SCIENCE STANDARDS

DRAFT INTERIM CONTENT AND PERFORMANCE STANDARDS

SUPERINTENDENT'S CHALLENGE INITIATIVE

THE CHALLENGE INITITATIVE

INTRODUCTION

The Challenge School District Reform Initiative calls on California's educators and parents to embrace a simple but powerful concept: school districts must set high content and performance standards for student achievement—stating clearly and publicly what each student should know and be able to do at the end of each year in each subject area. Schools are challenged to hold themselves accountable for results, reporting precisely how well their students are achieving and how many students are meeting the school district standards.

To further the Challenge Initiative, the following Draft Interim Content and Performance Standards, "Challenging Standards for Student Success," have been developed in language arts, mathematics, history-social science, science, health education, physical education, visual and performing arts, foreign language, applied learning, service learning, and career preparation. Each set of standards includes an introduction, standards by grade level, examples of the types of work students should be able to do to meet the standards, and samples of specific activities or tasks that give students the opportunity to demonstrate that they can meet the standards. Some sets of standards also include samples of student work that meet the standards, and a few have short commentaries on these samples.

The draft Challenge Standards are a product of collaboration among representatives of school districts interested in the Challenge Initiative, curriculum specialists, teachers, and California Department of Education staff. Small working groups began the initial development of the standards in October 1995 and work on them continues, using as a basis the national standards including those from the New Standards Project; school district standards; California curriculum frameworks; and *Every Child a Reader* and *Improving Mathematics Achievement for All California Students*, the Superintendent of Public Instruction's 1995 task force reports on reading and mathematics. In December 1995 the working groups submitted their drafts to the California Department of Education. The complete set of draft Challenge Standards was distributed to representatives of the school districts interested in the Challenge Initiative at a meeting in Sacramento on December 14, 1995.

Several national and state reform efforts promote the development of standards. The New Standards Project, for example, builds on content standards developed by national professional organizations to design an assessment system based on world-class standards of student performance. Improving America's Schools Act of 1994 (IASA) requires school districts to measure student progress toward achieving rigorous state content and performance standards. California Assembly Bill 265, enacted in 1995, also requires the California State Board of Education to adopt academically rigorous statewide content and performance standards.

As part of the Challenge Initiative, participating school districts will now begin to (1) determine how the draft Challenge Standards relate to local standards, (2) gather samples of student work related to each standard, and (3) examine the student work to determine whether or not students are able to meet each standard.

When completed, the content and performance standards will establish a clear set of expectations for what students should know and be able to do at every grade level. These standards are in draft form and continue to be refined. Therefore, any comments are appreciated. General comments and questions about the draft Challenge Standards may be directed to the Assessment Office at (916) 657-3011. Specific comments and questions may be directed to the individuals listed below.

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SCIENCE

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SCIENCE STANDARDS

INTRODUCTION

Science standards enable schools to give future citizens the knowledge and process tools they need to function for the betterment of society. Standards exist to improve instruction and to assess student achievement. If California is to maintain its world leadership it must have its citizens grounded with the content and process of science that has become commonly known as "scientifically literate." It is to this end that these standards are established for the Challenge Districts and for all Californians.

UNDERLYING PRINCIPLES

California, through many efforts, has been working on standards and assessment. The state has played a large role in the development of national standards. The California Department of Education has produced documents that have been used nationwide, namely the *Science Framework*—1990, *Big Ideas of Science*, and *A Sampler of Science Assessment*. It is fitting then, that the standards developed for the Challenge Districts reflect these efforts. The basic assumptions underlying standards are in the curriculum, instruction and assessment.

To meet the standards students must experience a curriculum that ensures equal opportunity and access for all students to learn and demonstrate their understanding of the "big ideas" of science. The core of the curriculum is inquiry, problem-solving, and investigation, and is focused on understanding the content of science, including scientific skills and processes. Standards exist to help schools/districts create a rigorous, high quality science program which will raise student achievement and create scientifically literate citizens.

STANDARDS OF STUDENT ACHIEVEMENT IN SCIENCE

The purpose of science performance standards is to enable today's students to become literate in science. That is not to say they should do science or become scientists, but that they are able to have science as a habit of mind. Science enables people to observe, reflect and conclude in logical sequences. Science explains the constantly changing technologies that enter and leave their lives. Finally, citizens need to make wise local and global choices for living, voting, interpreting media, and vocational selection. A strong science background put to good use improves the quality of life for all citizens. Standards assure that students have had the opportunity to obtain the necessary education to become scientifically literate.

BASIC ASSUMPTIONS

Standards must reflect the nature of science. Standards should be easy to demonstrate and explain. Standards should be developmentally appropriate. Standards should reflect national and world-wide trends in science education. Standards should be assessable and/or demonstrable. Standards should be based upon the "big ideas" of science as opposed to memorizing facts. Students should be able to meet the standards in a variety of ways. Standards are experiences for children that serve as the norm, the expected, the given. When measuring standards there are several categories of achievement such as: does not meet the standard, meets the standard, and exceeds the standard. These will be determined by rating examples of actual student work. Standards can and should change as new information is received. Standards must be free from gender, racial, and ethnic skewing.

WHAT ARE THESE SCIENCE STANDARDS?

These science standards are based upon from the "big ideas" of science generated for California assessment. The National Science Standards, Benchmarks for Scientific Literacy and New Standards also

served as bases. In many cases, the original 35 big ideas have been combined or condensed into new ideas while keeping the attachment to the 1990 *Science Framework*.

The standards are the guide, the sign posts, the flavor of K-12 science. They are samples of what one would find in a sound science program. They indicate what students who are making headway would be able to know and do.

The standards are a combination of content and performance skill standards because it is difficult to delineate between performance and content standards in science.

The samples of the standards were generated by a group of science teachers over a six-day period in November 1995. They are tied to national efforts because many of the ideas were taken directly from the efforts of the National Research Council, the American Association for the Advancement of Science, NSTA, and the Learning Research and Development Center Consortium. They are small samples; each standard would need two or more pages to explain processes and procedures necessary to reach the standard. They are simply samples of the types of activities one would find in a successful classroom. There are thousands of parallel activities and teaching strategies that do the very same thing.

ACCESS – EQUITY – EXCELLENCE – ASSESSMENT

Standards cause districts to evaluate their programs. Basic to all levels of science are questions to consider concerning scientific literacy and access, equity, excellence, and assessment for all students:

- Do all students, regardless of cultural or ethnic background, gender, physical/learning disabilities, have access to science learning?
- Are all students included and encouraged to pursue vigorous and challenging science opportunities?
- Does science assessment provide opportunities for all students to demonstrate their understanding and progress?

SCIENCE STANDARDS

GRADES K-2

THE PREPARED MIND

STANDARD 1:

Students exhibit curiosity, open-mindedness, and the ability to think critically in daily life.

Examples of the types of work students should be able to do to meet the standard:

- Observe the surrounding world and be willing to seek answers
- Ask "How do you know?" in appropriate situations and attempt reasonable answers when others ask that question
- Persist in investigating the ways of classifying materials
- Identify patterns in nature and in personal daily activities
- Begin to understand the concept of "fair test"

PHYSICAL SCIENCE

Big Idea: Properties of Matter

There is a wide variety of matter. The properties of matter give rise to the great variety. Properties can be observed, described, and measured.

STANDARD 2:

Students demonstrate that matter has properties that can be observed, described, and recorded.

Examples of the types of work students should be able to do to meet the standard:

- Describe the shape, texture, temperature, size, and color of various objects
- Compare various objects for similarities and differences
- Classify various objects based upon observable properties
- Explore and relate differences between ice and water
- Develop a permanent list of properties for the classrooms—use student words as well as science words e.g., "squishy"

Samples of specific activities or tasks that give students the opportunity to demonstrate that they can meet the standard:

Students will communicate, orally or by illustration, about the properties of an unfamiliar object, describing several attributes including shape, texture and color and state of matter. Students will demonstrate the ability to group and classify a number of objects.

PHYSICAL SCIENCE

Big Idea: Energy Transformations

Energy is transferred to and from systems of matter as they interact**,** but if all **i**nteractions are taken into account, any energy lost by one system is gained by some other system(s).

STANDARD 3:

Students identify forms of energy that are observable as light, heat, sound, and motion.

Examples of the types of work students should be able to do to meet the standard:

- Compare hands before and after rubbing them together to identify the forms of energy and trace the energy flow
- Observe and describe the difference between striking a cup or not striking a cup when it is placed against the ear
- Compare the surface of the water before and after a vibrating tuning fork is placed on the surface
- Observe and describe how the light from a flashlight is affected by placing a piece of black construction paper or some clear object over it
- Demonstrate solar energy using a solar cell-operated toy by observing it with and without light and tracing energy flow

Samples of specific activities or tasks that give students the opportunity to demonstrate that they can meet the standard:

Using a solar oven, students will identify forms of energy involved in cooking and will describe these forms using pictures and words.

PHYSICAL SCIENCE

Big Idea: Light

Light has sources and has properties that can be measured such as color (frequency) and intensity. Light and matter interact at the atomic level. Visible light is one form of energy on the electromagnetic spectrum.

STANDARD 4:

Students show how light can be produced by many sources and has observable properties such as color and intensity.

Examples of the types of work students should be able to do to meet the standard:

- Compare different sources of light: candles, flashlight, the sun
- Compare the intensity of light through various materials
- Describe experience with light and shadow while playing shadow tag—note poem "I have a little shadow"
- Construct a shadow theater and have a light show to illustrate various light/shadow forms
- Relate various light experiences—e.g., neon lights, rainbows, flashlights, and lasers—then list how they are alike and how they are different

Samples of specific activities or tasks that give students the opportunity to demonstrate that they can meet the standard:

Students draw as many different sources of light in their classroom, home, and outside and classify these sources by brightness and color.

PHYSICAL SCIENCE

Big Idea: Magnetism and Electricity

Magnetism and electricity are related. Both are forces that have many uses in our everyday lives.

STANDARD 5:

Students show that magnets can be used to move things without touching them.

Examples of the types of work students should be able to do to meet the standard:

- Observe how a magnet is a push or pull and how magnets have opposite poles that either attract or repel
- Observe and demonstrate how some objects can be moved by magnets without touching the object
- Classify objects that are attracted by magnets
- Identify objects at home that use magnets and those that do not—e.g., door seal of refrigerator, catches on cupboards

Samples of specific activities or tasks that give students the opportunity to demonstrate that they can meet the standard:

In learning centers, students will explore the properties of magnets using various objects. They see which objects move when a magnet is placed near them and classify the objects into magnetic and non-magnetic groups. By using small items students can sort magnetic and non-magnetic items and tape them to a sheet of paper.

PHYSICAL SCIENCE

Big Idea: Changes in Matter

The properties of matter and their physical or chemical changes are affected by the conditions under which they occur, such as the amount of heat and pressure.

STANDARD 6:

Students show that matter may exist as a solid, liquid, or gas.

Examples of the types of work students should be able to do to meet the standard:

- Observe and describe three classroom objects as solids
- Describe the characteristics of a variety of materials in the liquid and solid state
- Compare the relative weights of a filled and unfilled balloon
- Observe the behavior of feathers and leaves in moving air
- Observe melting of ice, evaporation of water, freezing of water

Samples of specific activities or tasks that give students the opportunity to demonstrate that they can meet the standard:

Various samples of solids, liquids, and gases are provided; students identify and classify them as solids, liquids, or gases. Conduct a state of matter scavenger hunt on the school yard.

PHYSICAL SCIENCE

Big Idea: Structure of Matter

All matter is composed of the same fundamental building blocks.

STANDARD 7:

Students identify and use objects made of matter with a variety of names, recognizing the type of matter by its attributes.

Examples of the types of work students should be able to do to meet the standard:

- Classify a group of objects according to their similarities, such as objects made of wood, plastic, cloth, or metal.
- Compare and contrast items that are mostly water
- Compare six or seven different white soap bars, describing how they are alike, how they are different, and whether or not they all clean the same, then graph the results
- Compare and describe characteristics of wood, wood splinters, wood shavings, sawdust, wood furniture, and wooden pencils
- Compare characteristics of metals, such as metal shavings and metal dust

Samples of specific activities or tasks that give students the opportunity to demonstrate that they can meet the standard:

Students will classify a collection of various objects, based upon certain attributes. They will draw or write their categories and present their results.

PHYSICAL SCIENCE

Big Idea: Mechanics

Unbalanced forces cause changes in motion.

STANDARD 8:

Students show their understanding that a force is a push or a pull.

Examples of the types of work students should be able to do to meet the standard:

- Observe and describe various effects on objects when they are pushed
- Observe and describe various effects on objects when they are pulled
- Communicate that “pushes” and “pulls” are forces
- Observe and describe a variety of balls when dropped, identifying forces and materials that determine the “bounce”
- Identify gravity as the force that acts on dropped objects

Samples of specific activities or tasks that give students the opportunity to demonstrate that they can meet the standard:

Students will demonstrate, using an object, the various forces of "push," "pull," and gravity, using the appropriate terms.

PHYSICAL SCIENCE

Big Idea: Energy and Work

Energy can produce work.

STANDARD 9:

Students show their understanding that energy is needed to do work.

Examples of the types of work students should be able to do to meet the standard:

- Observe various actions, such as opening a soft drink can or lifting a book, that demonstrate work being done
- Compare energy being expended as students walk/run/skip/hop a certain distance or while sharpening a pencil
- Relate work to movement by having students do an activity such as reading a book, doing math, or watching television, then comparing it to moving something
- Identify energy sources for human work
- Compare the amount of energy needed when pushing a full and empty wagon

Samples of specific activities or tasks that give students the opportunity to demonstrate that they can meet the standard:

Students will draw or write about examples of common activities that demonstrate "work" requiring energy.

PHYSICAL SCIENCE

Big Idea: Sound

Sound is produced by the vibration of matter.

STANDARD 10:

Students demonstrate that the movement of certain objects produces sound.

Examples of the types of work students should be able to do to meet the standard:

- Observe a rubber band vibrating when it is stretched and plucked
- Compare how the sound changes when a string is plucked at different intervals on a stringed instrument, such as a guitar
- Compare the movement of water in two glasses, one struck with a pencil and the other left alone
- Identify and compare the different parts that move, producing the sound in primary musical instruments
- Experiment with making sounds such as whistle, clap, stomp, howl, hissing noise, hand over mouth, then identify the vibrating parts

Samples of specific activities or tasks that give students the opportunity to demonstrate that they can meet the standard:

Students will classify objects that produce or don't produce sounds from a collection of objects. They will draw or write what was moving to have caused the objects to produce their sounds and report their results.

LIFE SCIENCE

Big Idea: Cell

Cells are the basic functional unit of all living things.

STANDARD 11:

Students demonstrate an understanding that living things are made of smaller structures.

Examples of the types of work students should be able to do to meet the standard:

- Use a magnifying glass to find the smaller parts of items (e.g., skin, part of leaves, fabric)
- Label body parts and plant parts as part of the whole and discuss what would happen if one of the parts were missing or different
- Take a nature hike and find the smallest part of a whole (e.g., part of a leaf, feather)
- Use a toilet paper tube to view a large stationary object (e.g., another student) at various distances that are increasingly closer, draw successive view and discuss the differences
- Observe and describe living things (e.g., sunflowers, pine cones, honey combs) and find the smallest pattern

Samples of specific activities or tasks that give students the opportunity to demonstrate that they can meet the standard:

Given an unfamiliar object, students will make a prediction drawing of what the object will look like with a hand lens. Students will then view the object with a hand lens, draw it, and compare it to their prediction.

LIFE SCIENCE

Big Idea: Structure/Function

Living things demonstrate a structure/function relationship enabling them to survive in their environment.

STANDARD 12:

Students demonstrate an understanding that living things have features that enable them to survive.

Examples of the types of work students should be able to do to meet the standard:

- Sort animal pictures by areas in which they move (land, air, water), observe and describe the sorted pictures to determine if they have similar features
- Observe and describe plants (including fruits and vegetables) and animals, compare and contrast how the body covering acts as protection
- Observe, compare, and describe various seed types and explain how their shape/casing helps them to be distributed

- Use a variety of sense-related activities (e.g., touch box. taste test) to identify senses and describe daily activities using the same senses
- Compare and describe the teeth of several animals including humans and explain how their shape helps perform the function (e.g., tear, pierce, grind)

Samples of specific activities or tasks that give students the opportunity to demonstrate that they can meet the standard:

Students will construct a flip book of different types of animals body parts (e.g., legs, tails). Given different environments (e.g., land, air, water) students will use the flip book to make animals with features that match the environment and explain their choices.

LIFE SCIENCE

Big Idea: Diversity

Living things are diverse.

STANDARD 13:

Students demonstrate an understanding that living things have describable characteristics which distinguish them from nonliving things.

Examples of the types of work students should be able to do to meet the standard:

- Observe, compare and contrast the needs of plants and animals with non-living things
- Draw your favorite plant and animal, share the drawing with the whole class, and develop a list of characteristics they have in common
- Read a piece of literature, such as "I Love You Forever" by Nancy Munsch, and discuss how the needs of the characters are met
- Observe two plants, water one and not the other, and describe the results
- Sort seeds by their structure and appearance, and graph the variations (e.g., color, texture, smell, shape)

Samples of specific activities or tasks that give students the opportunity to demonstrate that they can meet the standard:

Given a set of five objects, the student will make a list of their characteristics and then sort them into living and non-living groups based on their features. Students will explain their rationale for the sorting.

LIFE SCIENCE

Big Idea: Heredity

Genetic characteristics are passed from one generation to another with modification.

STANDARD 14:

Students demonstrate an understanding that all living things have life cycles and that within each cycle the young are similar to but not identical to their parents.

Examples of the types of work students should be able to do to meet the standard:

- Illustrate the stages of growth for an animal or plant and sequence them appropriately
- Raise meal worms or silk worms and describe and discuss the life cycle

- Read a piece of literature such as "The Hungry Caterpillar" by Eric Carle and discuss the relationship to a life cycle
- Match pictures of parents and offspring and explain reasoning for the matches
- Chart physical differences and similarities between child and parents and between child and siblings

Samples of specific activities or tasks that give students the opportunity to demonstrate that they can meet the standard:

Students will list ways that offspring can be different from the parents using pictures of common animals, e.g., horse and foal, cow and calf.

LIFE SCIENCE

Big Idea: Interdependence

All living things are interdependent with their physical environment and with other living things.

STANDARD 15:

Students demonstrate an understanding that living things need resources from their environment to live and grow.

Examples of the types of work students should be able to do to meet the standard:

- Raise a classroom pet and keep a class journal of its daily needs and report your findings to another class
- Observe the needs of animals, plants and describe how the needs are similar or different
- List all the things needed on a camping trip to an undeveloped area and explain why you need those items
- Take a nature walk, draw pictures of where living things live, and explain why you think they live there
- Read a piece of literature such as *Charlie Needs a Cloak* by Tommy de Paola, and discuss how the products used by each living thing come from the environment

Samples of specific activities or tasks that give students the opportunity to demonstrate that they can meet the standard:

Given a plant to grow, students will decide how to care for it while recording the progress for a month. After class discussion of all plants grown in the classroom, students will describe/illustrate the conditions which lead to success or failure of plant growth.

LIFE SCIENCE

Big Idea: Evolution

Living things evolve through time.

STANDARD 16:

Students demonstrate an understanding that life has been on earth for a very long time and that some living things that once lived have disappeared, although they were something like those that are alive today and new species of organisms have evolved at many times.

Examples of the types of work students should be able to do to meet the standard:

- Collect pictures of as many types of living things as you can – make a class collage of the pictures and compare to photos of prehistoric animals
- Take a nature walk and identify living things in the local environment – discuss how it would have looked in the past or far into the future
- Compare pictures of fossils to present-day living things and discuss the rationale for similarities and differences
- Review a variety of fossils of different eras or use videos/pictures of dinosaurs and their environment – as a class, compare the observations to how life exists today
- Study pictures of your local area as it looked years ago – identify which features are still present in the area and which features have changed

Samples of specific activities or tasks that give students the opportunity to demonstrate that they can meet the standard:

Draw an animal. Draw in things that it would need to live. Draw another picture of things that would harm your animal. What would happen if there were more harmful than helpful things?

LIFE SCIENCE

Big Idea: Energy Flow

Living things are tied to one another and to their physical environment by the transfer and transformation of matter and energy.

STANDARD 17:

Students demonstrate an understanding that all living things need to take in water, that animals need to take in food, and that plants need sunlight. (Note: there are six kingdoms; plants and animals are the most common.)

Examples of the types of work students should be able to do to meet the standard:

- Compare and contrast the effect of specific amounts of water on plants over a certain period of time
- Listen to a piece of literature such as "Bringing the Rain to Kapiti Plain" by Vera Aardema and compare how the plants and animals react to the drought; compare with droughts in your area
- Observe, compare, and contrast the way in which different animals eat
- Grow two green plants, one in sunlight and one in the dark; observe, compare, and contrast the results
- Given pictures of several animals and plants, build a simple food chain mobile that shows what eats what

Samples of specific activities or tasks that give students the opportunity to demonstrate that they can meet the standard:

Students will construct a story board of a plant or an animal that demonstrates the need for water, food, and sunlight.

EARTH SCIENCE

Big Idea: Geology

Geological processes explain the evolution of the earth.

STANDARD 18:

Students identify changes on the earth's surface that are caused by the interaction of wind, sun, and water observe that tectonics also plays a major role.

Examples of the types of work students should be able to do to meet the standard:

- Observe different soils and rocks and explain how they are alike and different (materials)
- Observe an area near the school, describing land forms that can be seen. Compare photographs taken two to three generations ago with current photographs of the same, or similar, areas (land forms)
- Observe the effects of water sprayed and poured on exposed soil, blacktop, and grass. Compare these observations to the effects on the playground before and after a rain or wind storm (weathering)
- Identify as many different things as possible that change quickly and slowly on the school playground (change over time)

Samples of specific activities or tasks that give students the opportunity to demonstrate that they can meet the standard:

Students predict what a given pan of soil will look like when a small stream of water is slowly dripped on top of the soil. They perform the experiment to test their prediction.

EARTH SCIENCE

Big Idea: Astronomy

The universe, which is evolving, contains many objects including planets, stars, and moons. The laws of science apply throughout the universe.

STANDARD 19:

Student identifies objects in our solar system, including planets, moons and stars that are directly observable.

Examples of the types of work students should be able to do to meet the standard:

- Observe and describe the day and night cycle throughout the seasons, keeping track of activities and phenomena related to differences between day and night (e.g., types of clothing, amount of light at waking or bedtime, behavior of animals, etc.) (cycles/patterns)
- Observe objects in the sky and describe their motion over time (e.g., at the same time over a period of days, at regular intervals during the same day, seasonally, etc.) (motion)
- Observe and describe the relative size of objects at different distances from the observer—explain how the size of objects seems to change (scale and structure)
- Observe and describe the position of the sun in relation to the horizon at various times during the day using nonstandard units of measure (e.g., length of noon-time shadows, hand-widths above the horizon, sundial, etc.) (tools and measurement)
- Observe and describe a model of the relative positions of the earth, moon, and sun (systems)

Samples of specific activities or tasks that give students the opportunity to demonstrate that they can meet the standard:

Students will observe the moon over a specified period of time. They pick a time each day and a constant place to stand to look at the moon. They describe how it changes position and shape.

EARTH SCIENCE

Big Idea: Resources

The earth has limited resources that are unevenly distributed on the earth's crust.

STANDARD 20:

Student identifies resources that come from the earth and sun.

Examples of the types of work students should be able to do to meet the standard:

- Identify earth's resources that humans need in order to survive (e.g., water, air, minerals, soil and energy) (human needs)
- Relate responsible use of earth's resources to objects and materials in the school yard (resources)
- Compare things grown or manufactured locally with those grown or manufactured nonlocally (uneven distribution)
- Observe and describe a closed ecosystem over a period of time (e.g., terrarium, aquarium, etc.) and predict what would occur if one condition were changed (biophysical principles)
- Identify a local problem and design a plan to address the issue (e.g., pick up trash, recycle aluminum cans, replant a local drainage, etc.) (informed decision-making)

Samples of specific activities or tasks that give students the opportunity to demonstrate that they can meet the standard:

Students draw a picture of the items in their lunch and make a poster illustrating from which of the earth's resources each item came (e.g., the soda can comes from minerals in the earth, the soda is composed mainly of water.)

EARTH SCIENCE

Big Idea: Meteorology

Energy from the sun, interacting with the ocean, atmosphere, and land masses, produces climate and weather.

STANDARD 21:

Student demonstrates an understanding that weather changes day by day, season by season, and is the condition of surrounding air. Student demonstrates an understanding that the sun heats water, earth, and air, and that the sun is the cause of our weather.

Examples of the types of work students should be able to do to meet the standard:

- Observe, chart and compare changes in weather patterns over two or more seasons (weather changes in patterns)
- Observe and describe how human activities, clothing, and housing change based upon the weather and season (impact)

- Use tools such as thermometers, wind streamers, and cloud charts to measure changes in weather (tools and technology)
- Observe evidence of the water cycle by comparing water left in closed containers, open containers, in a puddle on the sidewalk and/or on different surfaces, etc. (water cycle and energy)
- Observe evidence of the sun's energy by comparing the temperature of different objects left in sunlight and shade (energy transfer)

Samples of specific activities or tasks that give students the opportunity to demonstrate that they can meet the standard:

Students match sets of weather pictures and pictures of different types of clothing with pictures of clouds that might be observed during that weather. They explain their selections.

EARTH SCIENCE

Big Idea: Oceanography

Oceans play a central role in the global ecosystem and in the formation, evolution, and continued support of life on earth.

STANDARD 22:

Student identifies observable characteristics of the ocean and demonstrates an understanding that the oceans are vast bodies of salt water covering most of the earth's surface and supporting many forms of life.

Examples of the types of work students should be able to do to meet the standard:

- Compare the amount of land to the amount of water on the earth's surface, and relate to where people live (impact)
- Observe and compare the properties of salt water and fresh water (e.g., evaporation of salt water and fresh water under different conditions, floating and sinking of an object, etc.) (properties)
- Observe and describe evidence (shells and fossils) that oceans once covered a local geographic area (change)
- Observe and describe results of evaporation of fresh and salt water (interaction with land and air)
- Compare animal life found in the ocean with animals found on land by cutting and pasting pictures (integration)

Samples of specific activities or tasks that give students the opportunity to demonstrate that they can meet the standard:

Students will predict which objects will float or sink in fresh or salt water. They will then test the objects to verify their predictions.

INTEGRATED SCIENCE

Big Idea: Energy

The universe is affected by various forms of energy flowing throughout all systems. Living and nonliving systems change as a result of energy transformations.

STANDARD 23:

Students demonstrate an understanding that the results of energy flow can be observed around us.

Examples of the types of work students should be able to do to meet the standard:

- Identify the effects of the wind, sun, and water on the environment
- Observe and describe the effect of eating food on a student's energy level
- Describe and compare the ways that energy is used to power cars, airplanes, and trains
- Observe and describe how the wind can be used to help objects move from place to place; e.g., toy sailboats in a child's wading pool
- Identify the effect of tree roots growing underneath and cracking sidewalks or pavement

Sample of specific activities or tasks that give students the opportunity to demonstrate that they can meet the standard:

Students will create a booklet of drawings and simple writing that successfully illustrates that energy in different forms can change the world around them.

SCIENCE TOOLS

STANDARD 24:

Students use tools to perform tasks more easily, compare things to standard measure, and enhance the senses.

Examples of the types of work students should be able to do to meet the standard:

- Given a choice of tools and materials, perform expected primary tasks with hammers, screwdrivers, balances, clamps, saws, scissors, measuring cups and many others
- Use nonstandard units to measure length, volume, and mass, using whole numbers and everyday fractions
- Use technological tools to communicate and gather information, i.e., telephone, tape recorder, and others
- Use tools to order, count, identify, measure, and describe things
- Make something designed out of simple materials to perform a task
- Measure with nonstandard units—estimate

INVESTIGATIONS

STANDARD 25:

Students investigate problems, sometimes over extended periods, make choices about experimental design, and may include ideas, concepts, and processes using controlled experiments, previous research data, field studies, and conclusions.

Examples of the types of work students should be able to do to meet the standard:

- Formulate problems
- Ask questions to find out about a problem
- Make and record observations, some over an extended period of time, so data can be compared—when different people have different descriptions, make and record further observations
- Design a solution to a problem and then improve upon the design through trial and error
- Explain why things happen
- Record experiences with materials, systems, and interactions as a foundation for the invention of concepts
- Seek and record information from observations by trying things out and from reference sources such as books or other people
- Listen and respond to explanations or observations of another person

COMMUNICATIONS

STANDARD 26:

Students use a number of ways to communicate clearly about the natural world.

Examples of the types of work students should be able to do to meet the standard:

- Describe process used in solving a problem
- Work independently and with a partner to collect and share information and ideas
- Talk and listen to a partner to solve a problem or complete a procedure
- Listen to and record ideas and observations of others
- Represent information in different ways, i.e., numbers, drawings, words
- Explain ideas
- Show another person how something works
- Ask "How do you know?" in appropriate situations and attempt reasonable answers when others ask the same question
- Sequence a series of events

IMPACT OF TECHNOLOGY

STANDARD 27:

Students identify which solutions created by scientific endeavor are most useful in light of their cost-benefit ratio, i.e., pollution, risks, practicality.

Examples of the types of work students should be able to do to meet the standard:

- Test a variety of materials for making a particular thing; record which materials are best for solving a problem
- Invent and record new ways to solve problems and get work done
- Record "what works best" among a variety of products
- Record "what tasted best" among a variety of foods

DESIGNED WORLD

STANDARD 28:

Students use the resources of their environment to solve problems as people have throughout history through systematic and serendipitous problem solving and collaborations among disciplines.

Examples of the types of work students should be able to do to meet the standard:

- Investigate and describe the origins of the things they use every day
- Put parts together so that they can accomplish tasks they couldn't by themselves
- Use several steps to make something

SCIENCE STANDARDS

GRADES 3-5

THE PREPARED MIND

STANDARD 1:

Students exhibit curiosity, open-mindedness and the ability to think critically in daily life.

Examples of the types of work students should be able to do to meet the standard:

- Seek evidence to support opinions, statements and conclusions
- Recognize other's points of view; check explanations against experiences, observations, and knowledge
- Recognize when comparisons might be unfair because some conditions are not kept the same, further developing "fair test" concept
- Support arguments, statements, and conclusions with evidence from personal experiments, experiments of others, and information supplied from books and other media
- Keep and maintain honest records of observations and experimentation
- Provide explanations for ideas, incorporating ideas of others
- Identify patterns and construct relationships based on previous knowledge and experiences

PHYSICAL SCIENCE

Big Idea: Properties of Matter

There is a wide variety of matter. The properties of matter give rise to the great variety. Properties can be observed, described, and measured.

STANDARD 2:

Students show that matter can be changed.

Examples of the types of work students should be able to do to meet the standard:

- Observe and categorize the attributes of silly putty or crazy colloid (oobleck)
- Describe the changes observed when a raw egg is heated
- Describe the changes to paper when it is burned
- Order the changes observed as some sugar is "cooked" (from white solid to liquid caramel to solid carbon)
- Compare characteristics of a mixture of salt and iron filings

Samples of specific activities or tasks that give students the opportunity to demonstrate that they can meet the standard:

Students will observe and describe the states of matter and physical properties of a mixture of mystery powders. They will investigate the shape, color, texture, and smell of the powders. Students will then infer causes for the observed changes.

PHYSICAL SCIENCE

Big Idea: Energy Transformations

Energy is transferred to and from systems of matter as they interact**,** but if all **i**nteractions are taken into account, any energy lost by one system is gained by some other system(s).

STANDARD 3:

Students show an understanding that energy can be stored and transformed in observable ways.

Examples of the types of work students should be able to do to meet the standard:

- Design a circuit with battery that will light a bulb or ring a bell
- Heat a can of water with a candle and identify the forms of energy and flow
- Design a windmill and use it to lift a weight
- Make musical instruments and explain how motion is converted to sound
- Demonstrate how light from the sun can be converted to sound

Samples of specific activities or tasks that give students the opportunity to demonstrate that they can meet the standard:

Students will complete a circuit to light a bulb or produce sound.

PHYSICAL SCIENCE

Big Idea: Light

Light has sources and has properties that can be measured such as color (frequency) and intensity. Light and matter interact at the atomic level. Visible light is one form of energy on the electromagnetic spectrum.

STANDARD 4:

Students show that light travels through some materials but not others, recognizing that light may be reflected, absorbed, or a combination of both.

Examples of the types of work students should be able to do to meet the standard:

- Conduct experiments to determine materials that are transparent, translucent, and opaque
- Conduct a home/school survey on the uses of light and find ways that transparent, translucent, and opaque materials enhance our life
- Observe the effect of a prism on white light
- Observe red apples under red light and green apples under green light
- Build a color wheel and spin it to demonstrate how "white" light is composed of all the colors

Samples of specific activities or tasks that give students the opportunity to demonstrate that they can meet the standard:

Use a light box or build a kaleidoscope and demonstrate how and why it works.

PHYSICAL SCIENCE

Big Idea: Magnetism and Electricity

Magnetism and electricity are related. Both are forces that have many uses in our everyday lives.

STANDARD 5:

Students show an understanding that an electrical current produces a magnetic field.

Examples of the types of work students should be able to do to meet the standard:

- Observe a force field produced by a magnet using iron filings
- Demonstrate that magnets have a north pole and south pole and that opposite poles attract and that similar poles repel
- Construct a simple battery motor and locate its magnetic field
- Explain how a compass works, and describe how it can be used to find direction
- Demonstrate how falling water energy can be converted to electrical energy

Samples of specific activities or tasks that give students the opportunity to demonstrate that they can meet the standard:

Students can demonstrate the existence of magnetic fields created by electricity in various areas of their classroom by using a magnetic compass.

PHYSICAL SCIENCE

Big Idea: Changes in Matter

The properties of matter and their physical or chemical changes are affected by the conditions under which they occur, such as the amount of heat and pressure.

STANDARD 6:

Students show how heat affects matter contained in objects.

Examples of the types of work students should be able to do to meet the standard:

- Observe the effect of heat and cold on a volume of air
- Observe the change in size of a burning candle
- Observe the bimetal strip of a thermostat; heat and cool it
- Experiment to determine the best insulated foam cup on the market
- Describe what effects cooking has on food

Samples of specific activities or tasks that give students the opportunity to demonstrate that they can meet the standard:

Students will experiment with various objects, including samples of liquids and gases, to determine how changes in temperature affect the objects. They will collect their data and present their results.

PHYSICAL SCIENCE

Big Idea: Structure of Matter

All matter is composed of the same fundamental building blocks.

STANDARD 7:

Students show their understanding that matter is composed of small particles, too small to be seen individually.

Examples of the types of work students should be able to do to meet the standard:

- Compare the composition of sandstone or pumice rock with ground up samples; compare various types of rocks, dirt, sand, and potting soil, using a magnifying glass to make observations
- Observe the formation of crystals from supersaturated solutions, then develop models to explain the crystal growth
- Bake cookies with a mix of various ingredients, then try to separate parts out after cooking
- Observe sawdust, metal filings, and dirt, describing how they are related and how they differ
- Report on where the materials that wear off automobile tires go, being sure to give a scientific explanation to describe possibilities

Samples of specific activities or tasks that give students the opportunity to demonstrate that they can meet the standard:

Students will compare the component parts of three different shoes (purchased from a thrift store)—tennis, high heels, and a loafer—cut lengthwise. They will identify the basic materials, explain why certain materials are present in one type but not others, and present their results.

PHYSICAL SCIENCE

Big Idea: Mechanics

Unbalanced forces cause changes in motion.

STANDARD 8:

Student demonstrate that an object stays at rest until acted upon by unbalanced force and the greater the force, the greater the motion.

Examples of the types of work students should be able to do to meet the standard:

- Observe and compare the amount of force needed to move 1, 3, and 5 books over a specified distance
- Compare the difference in distance that a toy race car travels when different amounts of force are applied, using a rubber band launcher
- Compare the distance a race car travels from a ramp before and after doubling the load it
- Compare various lengths of levers having the same fulcrum distance to force output
- Observe the lines of force and interactions on a pool or air hockey table and report the general observations to the class

Samples of specific activities or tasks that give students the opportunity to demonstrate that they can meet the standard:

Students will use a variety of tools (such as a straw, spoon, and pencil) to move objects (spherical rocks, marbles, blocks of various sizes, shapes, and weight) from one place to another. They will design their experiment to compare the efficiency of their tools and the amount of motion of the objects, then report their results.

PHYSICAL SCIENCE

Big Idea: Energy and Work

Energy can produce work.

STANDARD 9:

Students demonstrate that when energy is added to a system, work may be produced.

Examples of the types of work students should be able to do to meet the standard:

- Observe the use of levers, inclined planes, wedges, and screws, when energy is applied to these devices to move objects
- Compare the amount of work produced when the same amount of energy is applied to two similar systems, such as two types of levers
- Identify specific examples of energies producing work for various energies: chemical, heat, light, electrical, atomic, mechanical, and sound
- Equate energy sources for various working items, e.g., gasoline for cars, electricity for elevators, and food for people, then describe which energy sources are inappropriate for the selected items
- Compare machines with the work they "save," e.g., street cleaners, escalators, stairs, pliers, bikes, and skates.

Samples of specific activities or tasks that give students the opportunity to demonstrate that they can meet the standard:

Students design and build a simple toy to demonstrate how, when energy is applied, work is produced.

PHYSICAL SCIENCE

Big Idea: Sound

Sound is produced by the vibration of matter.

STANDARD 10:

Students show their understanding that sound is created by the vibration of matter.

Examples of the types of work students should be able to do to meet the standard:

- Observe the vibration of a balloon piece stretched over the cut end of a cup when they speak into the cup
- Observe a vibrating blade of grass placed between two thumbs when air is blown across the grass
- Observe the vibrations caused by a piece of wax paper on a comb when air is blown across the surface
- Design and construct a simple musical instrument
- Relate the design of an instrument to the sound created

Samples of specific activities or tasks that give students the opportunity to demonstrate that they can meet the standard:

Students will construct a simple reed instrument using a soda straw. They feel the vibration of the tip against their tongue and adjust the pitch of the sound by lengthening or shortening the straw. Students build homemade kazoos to trace the vibration and try altering the sounds produced.

LIFE SCIENCE

Big Idea: Cell

Cells are the basic functional unit of all living things.

STANDARD 11:

Students demonstrate an understanding that all living things are made up of one or more cells and that complex multicellular living things have tissues, organs, and organ systems.

Examples of the types of work students should be able to do to meet the standard:

- Use technology (e.g., laser discs, computer) to observe the difference between a single-celled organism and a multi-cellular organism and discuss the similarities and differences
- Choose one human function (e.g., eating, sleeping, moving) and write a description of how the function works; research the function and explain how the research compares to the original ideas
- Build a model of how an organ or system works (e.g., muscles with popsicle sticks and rubber bands)
- Trace your body outline on a piece of paper, use cut out of heart, lungs, kidneys (organs) and place appropriately in the outline; investigate what makes up an organ
- Dissect a chicken wing and identify its major parts (e.g., skin, muscle, tendon, bone)

Samples of specific activities or tasks that give students the opportunity to demonstrate that they can meet the standard:

Using the following key: 1 lego = one cell; same color legos = tissue; two color legos = organ; multi-color legos = organ system; whole functional unit = organism, students will build an "organism" from cells, tissues, organs, and organ systems and explain how each part functions.

LIFE SCIENCE

Big Idea: Structure/Function

Living things demonstrate a structure/function relationship enabling them to survive in their environment.

STANDARD 12:

Students demonstrate an understanding that the structures of living things are adapted to their environment.

Examples of the types of work students should be able to do to meet the standard:

- Using a game with various pieces representing bird beaks and foods, students will describe the adaptation of bird beaks to food types

- Make a collage of animal adaptations and explain the types of environments in which the adaptations would work
- Observe and describe pictures of plants that live in deserts and tropical rain forests; draw a picture of the leaves and describe the relationships of the structure of the leaves with the environment in which they are found
- Observe, compare and contrast ear structures in different living things (e.g., rabbit, bat, frog, snake)
- Invent and describe different plants, showing how their structures help the plants to function in their environments (e.g., plants that can withstand high winds, live on the surface of a lake, store water, compete for sunlight)

Samples of specific activities or tasks that give students the opportunity to demonstrate that they can meet the standard:

Students will compare the skeletal structure of a bird, a four-legged animal and a human and describe how their structures enable them to move.

LIFE SCIENCE

Big Idea: Diversity

Living things are diverse.

STANDARD 13:

Students demonstrate an understanding that living things have similar needs that can be met in diverse ways and that different kinds of living things with similar characteristics can be sorted into groups.

Examples of the types of work students should be able to do to meet the standard:

- Observe, compare and contrast movement in five different types of animals (include invertebrates and vertebrates)
- Collect pictures and identify the differences between groups of animals, such as mammals, birds, worms, and insects
- Invent schemes for classifying animals and plants, and explain the classification
- Conduct an experiment comparing the amount of water needed by two different types of plants (e.g., cactus and "Wisconsin fast plant")
- Compare plants from two different environments such as a broad-leaf plant and a cactus

Samples of specific activities or tasks that give students the opportunity to demonstrate that they can meet the standard:

Construct a tree of life that has groupings of various plants and animals. List common characteristics, e.g., insects, spiders, evergreens.

LIFE SCIENCE

Big Idea: Heredity

Genetic characteristics are passed from one generation to another with modification.

STANDARD 14:

Students demonstrate an understanding that all traits between offspring and parents are inherited while other traits are more influenced by environmental factors.

Examples of the types of work students should be able to do to meet the standard:

- Investigate the presence of visible genetic traits in the class (e.g., attached or lobed ears) and find out if parents or other family members have the same traits
- Make a list of traits that living things get from their parents, traits they don't get from their parents, and traits that students are not sure about; discuss the lists and identify a trait that you want to research as to whether it is genetically or environmentally determined
- Research whether height is an inherited trait or determined by environmental factors; explain your conclusion based upon the research
- Choose a genetic trait and build a family trait tree to show how this trait was inherited (tree should go back as far as possible)
- Observe and compare various types of dog breeds and make a list of their similarities; investigate which of these similarities are genetic and which are environmentally determined

Samples of specific activities or tasks that give students the opportunity to demonstrate that they can meet the standard:

Given the description of several traits, the students will determine whether the traits are determined genetically or environmentally or by a combination of both factors. Students will give their rationale for their decision.

LIFE SCIENCE

Big Idea: Interdependence

All living things are interdependent with their physical environment and with other living things.

STANDARD 15:

Students demonstrate an understanding that living things interact with one another and their physical environment.

Samples of specific activities or tasks that give students the opportunity to demonstrate that they can meet the standard:

- Observe and describe how bills, wings, legs, and feet of various birds enable them to live in particular habitats
- Identify the daily, seasonal, and annual patterns of change within an ecosystem and discuss how these changes have an effect on the living and nonliving parts of this ecosystem
- Identify some of the resources that humans obtain from the earth, list their usages, and discuss what happens after usage
- Make a collage illustrating animals with adaptations well suited to the environment in which they live; explain your reasoning

- Compare and contrast two local communities, by measuring physical factors (e.g., soil moisture, air temperature) and listing the types of plants and animals found in those communities

Examples of the types of work students should be able to do to meet the standard:

Given the physical characteristics of an environment (e.g., meadow, estuaries, hardwood forest, beach/dunes, desert, and alpine forest) and the needs of bird X, the student will construct a nest that provides the best protection for the developing young.

LIFE SCIENCE

Big Idea: Evolution

Living things evolve through time.

STANDARD 16:

Students demonstrate an understanding that fossils can be compared to one another and to living things according to their similarities and differences and that these characteristics can be used to group organisms to show how they are related.

Examples of the types of work students should be able to do to meet the standard:

- Identify factors that have caused or may cause the extinction of certain plants and animals
- Make a variety of simulation fossils and explain the process for fossilization
- Classify a group of fossils and explain your rationale for the classification
- Trace the fossil history of one kind of animal
- Do an "archeological" dig to search for fossils, and discuss and then explain what the fossil evidence indicates about the animals and plants that were present

Samples of specific activities or tasks that give students the opportunity to demonstrate that they can meet the standard:

Given a set of fossils, students will classify them by common characteristics. Students will then be introduced to an "unknown" fossil and classify it using their classification scheme. Students will describe the environment in which the "unknown" might have lived.

LIFE SCIENCE

Big Idea: Energy Flow

Living things are tied to one another and to their physical environment by the transfer and transformation of matter and energy.

STANDARD 17:

Students demonstrate an understanding that energy (i.e., food) is needed for all living things to stay alive and grow, and that food chains cycle material from plants to animals and back to plants.

Examples of the types of work students should be able to do to meet the standard:

- Bring various food types to class representing your home culture and classify which kingdom provides the food source – graph the results or build a bulletin board

- Sing a song such as "Dirt Made My Lunch" by the Banana Slug Band and trace the source of the foods they have in the cafeteria for lunch
- Set up a worm bin to demonstrate how material is recycled; use the worm castings to plant seeds; observe the growth
- Construct a food web describing the relationships between the producers, consumers, and decomposers
- Use photos or drawings for each year of your life to create a "life-line" that lists the foods that you ate at each stage; compare and contrast to the life-line of another student in the class

Samples of specific activities or tasks that give students the opportunity to demonstrate that they can meet the standard:

Students will list the food their family consumes in a week. They will weigh resulting trash (food scraps and packaging) and design a plan that will reduce by 50 percent the amount of trash sent to the landfill.

EARTH SCIENCE

Big Idea: Geology

Geological processes explain the evolution of the earth.

STANDARD 18:

Student demonstrates an understanding that two processes account for the change in the earth's geologic features over time; that one process is the building of surface features by energy released from inside the earth (e.g., earthquakes, mountain building, volcanoes, etc.); and that the other process is the wearing down of features through erosion and weathering.

Examples of the types of work students should be able to do to meet the standard:

- Observe and sort different earth materials according to a variety of properties and relate them to the processes by which they were formed (materials)
- Compare various land forms—such as bays, beaches, islands, mesas, plateaus, buttes, canyons and valleys (surface and oceanic)—explaining how they were formed (land forms)
- Observe and describe how waves, wind, water, and ice shapes and reshape the earth's surface (weathering)
- Relate surface and oceanic land forms to geological changes over time (change over time)
- Build a model of three different types of fault zones that could cause an earthquake—review recent earthquake and volcanic activity in the local area (tectonics)

EARTH SCIENCE

Big Idea: Astronomy

The universe, which is evolving, contains many objects including planets, stars, moons. The laws of science apply throughout the universe.

STANDARD 19:

Student demonstrates an understanding that the patterns of movement of objects in the solar system are cyclic.

Examples of the types of work students should be able to do to meet the standard:

- Observe and describe how the tilt of the earth on its axis in relation to the sun affects the temperature and seasons at different locations on earth (e.g., tape photosensitive cards to a globe and shine a bright light at it) (cycles/patterns)
- Observe a model that uses a ball and light (motion) to illustrate the earth's rotation and the day and night cycle
- Compare relative size, distance, and position of the planets in relation to the sun (e.g., use scaled models of the planets spread across the playground) (scale and structure)
- Compare features of moon, earth and other planets using satellite images and binoculars (tools and measurement)
- Explain why a constellation is visible only at particular times of the year (systems)

Samples of specific activities or tasks that give students the opportunity to demonstrate that they can meet the standard:

Students will observe and record the apparent path of the sun. They will chart the times and position of the rising and setting sun. They will make a chart of the horizon line, and plot the relative distance of the sun above the horizon over an extended period of time. (Take usual safety precautions when viewing the sun.)

Students will construct an earthquake box to model action along a fault line during an earthquake. They will experiment with various amounts of force. Students will relate the amount of energy released in an earthquake to the amount of damage done.

EARTH SCIENCE

Big Idea: Resources

The earth has limited resources that are unevenly distributed on the earth's crust.

STANDARD 20:

Students demonstrate an understanding that people use air, water, soil, minerals and fossil fuels that come from the earth, and that some of these materials are nonrenewable.

Examples of the types of work students should be able to do to meet the standard:

- Identify earth resources found in the things people need and use (e.g., identify the source of local water supplies, map the location of water sources in California, and describe how water is distributed) (human needs)
- Classify earth resources in the things people use by their location in the world—construct a keyed map identifying the location of each resource (resources)
- Compare the origins of some common products and relate to the uneven distribution of earth resources (uneven distribution)
- Applying understanding of a local problem, design a plan to address the issue (e.g., pick up trash, recycle aluminum cans, replant a local drainage, participate in the Gemini Cricket Environmentally Challenge, etc.) (informed decision-making)

Samples of specific activities or tasks that give students the opportunity to demonstrate that they can meet the standard:

Students will gather phone books from four or more diverse locations (e.g., rural mountain or desert communities, urban areas, farming communities) and use the yellow pages to compare a variety of companies utilizing earth materials in different ways.

EARTH SCIENCE

Big Idea: Meteorology

Energy from the sun, interacting with the ocean, atmosphere, and land masses, produces climate and weather.

STANDARD 21:

Student demonstrates an understanding that weather and seasons result from the interaction of sunlight, the earth's rotation, land, water, and air masses.

Examples of the types of work students should be able to do to meet the standard:

- Observe types of clouds, the effects of temperature change and the speed and direction of the wind, and relate them to specific weather patterns (weather changes in patterns)
- Describe the effect of California's weather on the yearly fire, agricultural, and tourist seasons (impact on human activity)
- Make and use tools such as thermometers, anemometers, wind vanes, and barometers to record and measure changes in weather over a period of time (tools and tech)
- Compare the similarities and differences of the water cycle inside and outside Tony's house after reading *Water's Way* by Lisa Westburg Peters (watercycle and energy)
- Demonstrate how heat moves from something warmer to something cooler until they are both at the same temperature (energy transfer)

Samples of specific activities or tasks that give students the opportunity to demonstrate that they can meet the standard:

Students will apply their understanding of weather to explain relationships between mountain ranges and the water cycle. They will illustrate understanding of a rain shadow.

EARTH SCIENCE

Big Idea: Oceanography

Oceans play a central role in the global ecosystem and in the formation, evolution, and continued support of life on earth.

STANDARD 22:

Student demonstrates an understanding that the oceans have physical properties that play a central role in the global ecosystem, that they interact with sun, air, and land, and that they have changed through geologic time to provide many different habitats in which life has evolved.

Examples of the types of work students should be able to do to meet the standard:

- Compare the densities of salt water and fresh water, relating them to things that float and sink (impact)
- Compare the topography of the ocean floor with the topography of earth's surface (properties)
- Explain how fossils of ocean fish and shells can be found today in places geographically removed from the present day beach (e.g., at the top of mountains or in the Central Valley of California) (change)

- Compare weather data from coastlines and inland locations over a specified period of time—predict the weather in a coastal and inland location for an afternoon from a given set of data (interaction w/land and air)
- Classify and sort different plant and animal life into various ocean habitats (integration)

Samples of specific activities or tasks that give students the opportunity to demonstrate that they can meet the standard:

Students will apply their understanding of the oceans and ocean habitats by creating an ocean environment. Students will describe the plant and animal life found there, explaining the physical conditions that make them suited to that environment.

INTEGRATED SCIENCE

Big Idea: Energy

The universe is affected by various forms of energy flowing throughout all systems. Living and nonliving systems change as a result of energy transformations.

STANDARD 23:

Students demonstrate an understanding that energy can flow into and out of a system causing measurable changes.

Examples of the types of work students should be able to do to meet the standard:

- Describe and compare input and output with various forms of energy used at recess or in the cafeteria during lunch
- Compare the effects of various amounts of light on plants grown in sunlight, in artificial light, and in the dark
- Construct a food web mobile to show the energy flow from the sun to plants and animals, including humans
- Compare the various energy pathways used to produce paper and plastic products
- Survey energy use in the home or at a workplace to identify and diagram energy input and output

Samples of specific activities or tasks that give students the opportunity to demonstrate that they can meet the standard:

Students will observe how a meal is processed through the digestive system by using a blender, a one liter cube box, a long clear plastic tube with multiple perforations, and other materials. They will trace the flow of energy from the sun to the various food and packaging components, through the human body systems (digestive, muscular, circulatory, etc.). Students will produce a multimedia product that incorporates both visual and written forms of communication to present their results.

SCIENCE TOOLS

STANDARD 24:

Students use tools to perform tasks more easily, compare things to standard measure, and enhance the senses.

Examples of the types of work students should be able to do to meet the standard:

- Use standard measures to calculate length, volume, and mass
- Calculate using a pocket calculator, e.g., figures and averages of sets of data
- Use simple technology to extend the senses, e.g., prisms to view visible light, weather data equipment, and video cameras
- Choose appropriate common materials for making simple mechanical constructions and repairing things
- Utilize appropriate science tools such as graduated cylinders, force scales, thermometers, pan balances and masses, microscopes, pH paper, and calipers

INVESTIGATIONS

STANDARD 25:

Students investigate problems, sometimes over extended periods, make choices about experimental design, and may include ideas, concepts, and processes using controlled experiments, previous research data, field studies, and conclusions.

Examples of the types of work students should be able to do to meet the standard:

- Apply research from life experiences, previous education, and interview to an active investigation
- Design and conduct a fair test
- Conduct a systematic observation over time
- Design, build, and modify mechanical or biological system to meet a goal
- Conduct research using print, video, or computer information
- Explore in such a way that results are replicable
- Devise questions about objects, organisms, and events in the world
- Use evidence to construct and evaluate an explanation
- Identify problems, propose and implement solutions, and evaluate products or designs
- Using the data from one investigation, generate a prediction for a new investigation

COMMUNICATIONS

STANDARD 26:

Students use a number of ways to communicate clearly about the natural world.

Examples of the types of work students should be able to do to meet the standard:

- Collect, share, and record information and ideas individually and in teams
- Represent data and results in more than one way, for example, with numbers, drawings, words, and tables
- Use facts to support and evaluate the fairness of conclusions
- Write instructions that others can follow

- Communicate in a form suited to the purpose and the audience; use data from observation, experimentation, print and electronic media, and interviews to resolve disagreements
- Describe and illustrate the steps taken in solving a problem, including the resources used to build knowledge
- Use appropriate units to add meaning to numbers
- Use geometric figures, number sequences, graphs, diagrams, sketches, number lines, maps, and stories to represent objects, events, and processes

IMPACT OF TECHNOLOGY

STANDARD 27:

Students identify which solutions created by scientific endeavor are most useful in light of their cost-benefit ratio, i.e., pollution, risks, practicality.

Examples of the types of work students should be able to do to meet the standard:

- Conduct a product comparison test based on student-designed criteria of what determines product quality
- Discover and record how a solution to one problem can create another problem
- Develop more than one solution to a problem and compare them

DESIGNED WORLD

STANDARD 28:

Students use the resources of their environment to solve problems as people have throughout history through systematic and serendipitous problem solving and collaboration among disciplines.

Examples of the types of work students should be able to do to meet the standard:

- Use materials in different ways; describe recycling
- Compare various common inventions for their efficiency and ability to complete a desired task
- Work in pairs to create a solution to a task

SCIENCE STANDARDS

GRADES 6–8

THE PREPARED MIND

STANDARD 1:

Students exhibit curiosity, open-mindedness and the ability to think critically in daily life.

Examples of the types of work students should be able to do to meet the standard:

- Recognize that there may be more than one way to interpret a given set of findings
- Recognize and analyze, consider and critique alternative explanations; distinguish between fact and opinion
- Be skeptical of conclusions based on a very small sample, biased collection of data, or uncontrolled conditions
- Keep honest and accurate records
- Integrate concepts of physical, life, and earth science through inquiry, and apply concepts to the solutions of problems
- Arrive at a conclusion based on defensible evidence
- Continue to observe and question the surrounding world, recognizing interconnections among observations

PHYSICAL SCIENCE

Big Idea: Properties of Matter

There is a wide variety of matter. The properties of matter give rise to the great variety. Properties can be observed, described, and measured.

STANDARD 2:

Students demonstrate that some properties of matter depend on the amount of matter while other properties do not.

Examples of the types of work students should be able to do to meet the standard:

- Investigate the ways that a mixture of salt, sand, and flour could be separated
- Observe and measure properties of matter that depend on the total amount of the substance such as mass and volume
- Observe and measure properties of matter that are independent of the total amount of the substance, such as melting point, boiling point, solubility, and hardness
- Separate a mixture of liquids using the property of boiling points
- Observe whether various objects sink or float and apply the concept of density to explain why some sink and some float

Samples of specific activities or tasks that give students the opportunity to demonstrate that they can meet the standard:

Students design an experiment to determine the mass, volume, and density of an irregularly shaped solid object and an unknown liquid sample. The experiment will reflect scientific processes and conclusions.

PHYSICAL SCIENCE

Big Idea: Energy Transformations

Energy is transferred to and from systems of matter as they interact**,** but if all **i**nteractions are taken into account, any energy lost by one system is gained by some other system(s).

STANDARD 3:

Students show how energy transfers can be used to power a variety of products and services for human use.

Examples of the types of work students should be able to do to meet the standard:

- Sequence the series of energy transformations from breakfast food to energy expenditure while skate-boarding
- Explain energy transformation during the water cycle
- Compare and contrast a windmill and water mill as to how they transform energy to perform work
- Explain the science behind the term "work" and use examples from everyday occurrences
- Explain why heat is the "final" energy form in most energy transformations and give several illustrations

Samples of specific activities or tasks that give students the opportunity to demonstrate that they can meet the standard:

Students will conduct an energy audit of the classroom. In small groups, they identify the various types of energy transformations in the classroom and develop a model of how they could reduce energy consumption.

As a class, students will study several city systems in terms of energy use. In small groups, they will design a model city, showing the various types of energy used. They will provide data to show energy consumption and will describe the quality of life (what they had to give up and what they gained by their city design).

PHYSICAL SCIENCE

Big Idea: Light

Light has sources and has properties that can be measured such as color (frequency) and intensity. Light and matter interact at the atomic level. Visible light is one form of energy on the electromagnetic spectrum.

STANDARD 4:

Students show that light can be manipulated and is utilized by nearly all living things.

Examples of the types of work students should be able to do to meet the standard:

- Use a mirror to explore angles of incidence and reflection
- Design a system using sunlight to reduce electrical energy needs in your home
- Compare and contrast three identical plants placed in a light, semi-light, and dark location; then record and report the weekly results
- Construct a polarized light grid, and use it to show how light appears to travel as a wave or as a particle

- Investigate how solar-screen lotions work, report to the class what happens to unprotected skin, how sun screen protects, and what happens to the solar energy when it falls on protected skin

Samples of specific activities or tasks that give students the opportunity to demonstrate that they can meet the standard:

Students design a light path that navigates an obstacle course, and measure and compare the angles of incidence and reflection. Use regular or laser light.

PHYSICAL SCIENCE

Big Idea: Magnetism and Electricity

Magnetism and electricity are related. Both are forces that have many uses in our everyday lives.

STANDARD 5:

Students demonstrate that motion can produce electricity.

Examples of the types of work students should be able to do to meet the standard:

- Make a battery using salt solution and two metals for electrodes—e.g., iron and copper—then infer the flow of electrons in the circuit
- Observe what happens when a balloon is rubbed to produce a charged object that will attract other objects, such as hair or small pieces of paper
- Explain how one can get shocks from a rug or a car seat on a dry day
- Investigate a solar cell hooked to a motor; identify energy flow patterns and deduce the location of magnetic fields
- Investigate how radio, cellular phone, and television signals are transmitted; describe the roles of electricity and magnetism

Samples of specific activities or tasks that give students the opportunity to demonstrate that they can meet the standard:

Students will build a simple electrical motor using appropriate materials, such as wire, a battery, and a magnet. They will observe the difference in electrical current produced by their motor when they change the various parts, such as the strength of the magnet.

PHYSICAL SCIENCE

Big Idea: Changes in Matter

The properties of matter and their physical or chemical changes are affected by the conditions under which they occur, such as the amount of heat and pressure.

STANDARD 6:

Students demonstrate how pressure affects certain characteristics of matter.

Examples of the types of work students should be able to do to meet the standard:

- Observe what happens when pieces of clay are squeezed together
- Observe the reaction of a hammer on various woods to determine their hardness
- Describe what happens when a bicycle tire is pumped up and explain why the cylinder is warm
- Compare the difference in behavior when pressure is applied to a liquid or a gas
- Discuss the differences in pressure that create plate tectonic movements

Samples of specific activities or tasks that give students the opportunity to demonstrate that they can meet the standard:

Students design an experiment that will compare the relative changes in size, shape, and temperature as pressure is applied to various materials such as water, air, metal, and wood.

PHYSICAL SCIENCE

Big Idea: Structure of Matter

All matter is composed of the same fundamental building blocks.

STANDARD 7:

Students show their understanding that matter is composed of basic particles called atoms and molecules.

Examples of the types of work students should be able to do to meet the standard:

- Build molecular models of hydrogen, oxygen, carbon, and water, from marshmallows and toothpicks, then compare them
- Observe the effect of electricity producing oxygen and hydrogen gas from water
- Conduct a reaction of two clear solutions that produce a precipitate
- Build a list of common household chemicals giving their common name, chemical name, and formula
- Demonstrate how atoms can form molecules by using models or diagrams that show the sharing of electrons to create full shells

Samples of specific activities or tasks that give students the opportunity to demonstrate that they can meet the standard:

Given the chemical formulas, students will build models of simple atoms and molecules, such as hydrogen, oxygen, and water, and then construct more complex molecules, such as carbon dioxide and methane.

PHYSICAL SCIENCE

Big Idea: Mechanics

Unbalanced forces cause changes in motion.

STANDARD 8:

Students demonstrate that an unbalanced force acting on an object changes its speed, or alters its path.

Examples of the types of work students should be able to do to meet the standard:

- Compare the effects of moving the fulcrum on the balance of forces
- Observe pendulums of different weights, and different string lengths and report
- Compare paper airplanes with unequal wing weights, observing whether they move to the light or heavy side, then report findings to the class
- Investigate how unbalanced forces are used to steer airplanes, boats, and rockets, then report to the class

- Experiment with carts capable of holding various weights and pulling them with spring scales over different types of "road" materials such as sandpaper to observe the differences in force required to move the carts the same distance

Samples of specific activities or tasks that give students the opportunity to demonstrate that they can meet the standard:

Students will predict the relative forces needed to move a heavy object such as a cart loaded with books. They will design methods to increase speed or move the object with less force.

PHYSICAL SCIENCE

Big Idea: Energy and Work

Energy can produce work.

STANDARD 9:

Students show that when energy is applied to a system, a certain amount of energy appears to be "lost" but is, in fact, "transformed."

Examples of the types of work students should be able to do to meet the standard:

- Determine the number of simple machines in a bike, and demonstrate how they "lose" the energy the rider puts in
- Explain why machines cannot be 100 percent efficient, using concrete examples
- Compare the distance traveled by a small toy racing car when equal energy is applied but the track surface is changed by friction
- Compare the theoretical and actual amount of heat energy produced by burning a peanut under a beaker of water
- Relate things that people do to reduce the loss of energy by a machine, then report to the class and ask for other suggestions

Samples of specific activities or tasks that give students the opportunity to demonstrate that they can meet the standard:

Students build a model (e.g., car, boat) with a rubber band motor and compare the relative distances traveled to the energy applied and develop strategies to reduce energy loss.

PHYSICAL SCIENCE

Big Idea: Sound

Sound is produced by the vibration of matter.

STANDARD 10:

Students show their understanding that sound is a mechanical wave that transfers energy when it travels through a medium.

Examples of the types of work students should be able to do to meet the standard:

- Observe a moving Slinky
- Observe a vibrating tuning fork placed on the surface of a dish of water
- Describe the movement of energy from end to end of a string telephone
- Explain how energy is transformed into sound in a musical instrument
- Compare the physical features of sound waves to water, seismic, and light waves

Samples of specific activities or tasks that give students the opportunity to demonstrate that they can meet the standard:

Students will demonstrate and explain how vibrational energy is transferred from rubbing a finger along the rim of a thin-rimmed stemmed glass to create sound.

LIFE SCIENCE

Big Idea: Cell

Cells are the basic functional unit of all living things.

STANDARD 11:

Students demonstrate an understanding that living things have structural building blocks that are specialized to perform different functions, such as digestion, respiration, metabolism, water regulation, and reproduction.

Examples of the types of work students should be able to do to meet the standard:

- Use a microscope to compare and contrast plant and animal cells, and draw or build a model illustrating observations
- Use a microscope to view various tissues and describe their structure and relate this structure to its function
- Do a simulation of the importance of division of labor as it relates to specialization in multicellular organisms (e.g., have half the class work on a project individually and the other half work on the same product collaboratively, and compare the quality and quantity of the product in a given time)
- Dissect a worm and compare its circulatory or digestive system to a human's
- Compare and contrast transportation of materials in a plant and animal (e.g., goldfish tail under a microscope and celery with food coloring)

Samples of specific activities or tasks that give students the opportunity to demonstrate that they can meet the standard:

Using a Venn Diagram, compare and contrast a unicellular organism, an invertebrate, and a vertebrate. Discuss the functions common to all three.

LIFE SCIENCE

Big Idea: Structure/Function

Living things demonstrate a structure/function relationship enabling them to survive in their environment.

STANDARD 12:

Students demonstrate an understanding that living things in similar environments have structures, which function to make survival in their environment possible.

Examples of the types of work students should be able to do to meet the standard:

- Describe a variety of flower adaptations that promote insect pollination (e.g., color, mimicry, scent)

- Observe and diagram a root system of a plant best suited for an arid and moist climate; compare and contrast the two types
- Predict the characteristics of an animal that needs camouflage and one that does not; find examples to support the predictions
- Observe and describe two aquatic animals that use different modes of locomotion; compare and contrast specific body features that facilitate that movement
- Observe and describe a variety of invertebrates (e.g., clam, grasshopper, squid), relate structural/functional features to each animal's ability to survive predation

Samples of specific activities or tasks that give students the opportunity to demonstrate that they can meet the standard:

Select an invertebrate and prepare a written discussion of the similarities and differences in its structure/function as they relate to a human being. If environments were switched, how would these animals' survivability be affected?

LIFE SCIENCE

Big Idea: Diversity

Living things are diverse.

STANDARD 13:

Students demonstrate an understanding that each species shows variation among its members and differs from other species.

Examples of the types of work students should be able to do to meet the standard:

- Conduct a plot study and identify the diversity of animals and plants found within the study
- Survey the average height of students in one class and compare to the average height of students in another class of similar-age students; telecommunicate the results with a class from another state or country **or** analyze a group of items (e.g., oranges) for variations in size, weight, diameter, and sweetness
- Compare the variation between an island species to the same species on the mainland
- Differentiate between cats and small dogs using a classification scheme
- Dissect a worm and crayfish and discuss similarities and differences in the internal anatomy

Samples of specific activities or tasks that give students the opportunity to demonstrate that they can meet the standard:

Given an aquarium with populations of three different species of fish, students will describe through drawings and written communication, the similarities within the species groups and the differences among the three groups. Written communication will include graphing of some characteristics. Discuss how each group has a different niche in the aquarium environment, e.g., bottom feeders and top swimmers.

LIFE SCIENCE

Big Idea: Heredity

Genetic characteristics are passed from one generation to another with modification.

STANDARD 14:

Students demonstrate an understanding that some living things reproduce asexually, other living things reproduce sexually and that sexual reproduction results in a variety of individuals because the genetic material of the two parents interacts to form small changes.

Examples of the types of work students should be able to do to meet the standard:

- Research an example of a selective breeding (e.g., tomatoes, cows, chickens, dogs) and discuss the positive and negative effects of such breeding programs
- Describe the consequences of a world that only reproduces asexually
- Construct a Punnet square for simple traits and explain the results in terms of variety of individuals
- Determine the possibility and probability of having a certain type of offspring (possibility of a blue-eyed girl having two brown-eyed parents)

Samples of specific activities or tasks that give students the opportunity to demonstrate that they can meet the standard:

Given a list of dominant and recessive traits for an organism, students will create the traits for the parents and then predict the traits for the offspring.

LIFE SCIENCE

Big Idea: Interdependence

All living things are interdependent with their physical environment and with other living things.

STANDARD 15:

Students demonstrate an understanding that all parts of the ecosystem are connected, either directly or indirectly. Changes in one part of an ecosystem affect other parts of the ecosystem.

Examples of the types of work students should be able to do to meet the standard:

- Take a field trip to collect a pond culture, experiment with various ways (e.g., manipulating food, oxygen, light) to keep the culture viable over a period of time and discuss the results
- Design and construct an aquarium or terrarium system; observe and record observations over a period of time, discuss results
- Choose a local environment and construct a timeline to illustrate the changes over time in that environment, discuss the impact of one or more changes in the past and the implications for the future
- Participate in a simulation such as "Oh Deer" which demonstrates the population fluctuation due to environmental changes or examine the effects of increasing a school's student population by 30 percent
- Identify a pest in a local environment and by using an understanding of a food web propose three ways of controlling the pest and discuss the advantages and disadvantages of each

Samples of specific activities or tasks that give students the opportunity to demonstrate that they can meet the standard:

Research an ecosystem, such as a coastal tide pool, and construct a food web for this ecosystem. Describe the short-and long-term effects of the addition or removal of a group of like organisms.

LIFE SCIENCE

Big Idea: Evolution

Living things evolve through time.

STANDARD 16:

Students demonstrate an understanding that the fossil record documents the appearance, diversification, relationships, and extinction of many living things in relation to changes through earth's history and that living things are classified by considering their evolutionary relationships.

Examples of the types of work students should be able to do to meet the standard:

- Explain the lines of evidence showing that dogs and cats are related by common ancestors
- Describe the chain of events that over time, might lead to the evolution of a new species
- Make models representing geological formations that contain fossils and explain the how the sequence of fossils provides evidence for evolution
- Use a simple dichotomous key as a tool to identify different organisms
- Construct a simplified model of an animal's evolutionary history (camel, elephant, fish)

Samples of specific activities or tasks that give students the opportunity to demonstrate that they can meet the standard:

Working with line drawings of hypothetical organisms that share characteristics, construct a phylogenetic tree and explain the uniquely shared features that apply to each node on the tree.

LIFE SCIENCE

Big Idea: Energy Flow

Living things are tied to one another and to their physical environment by the transfer and transformation of matter and energy.

STANDARD 17:

Students demonstrate an understanding that food provides fuel and building materials for all organisms, and that plants make their own food by using energy directly from the sun, while animals ingest other organisms to obtain energy.

Examples of the types of work students should be able to do to meet the standard:

- Experiment with a calorimeter to determine the energy content of various items that burn
- Conduct an experiment to show the importance of sunlight on the process of photosynthesis (e.g., grow plants in the dark and others in light; test leaves for starch production)
- Bring in various labels for food items that they eat; analyze for calorie content and calculate the number of calories they consume in one day
- Construct a model of a biomass pyramid showing energy transfer from level to level

- Play a simulation game from a program such as Project Wild that indicates a food pyramid and explain the importance of the base population to the apex population

Samples of specific activities or tasks that give students the opportunity to demonstrate that they can meet the standard:

Students will design a flow chart to demonstrate the energy transformations involved between the sun and a student "surfing" on a skateboard.

EARTH SCIENCE

Big Idea: Geology

Geological processes explain the evolution of the earth.

STANDARD 18:

Student explains how the process of plate tectonics changes the surface of the earth. Student describes how the changes are powered by changes inside the earth and how exposed surfaces are altered by weathering.

Examples of the types of work students should be able to do to meet the standard:

- Relate the processes by which different rocks were formed by building a model that illustrates the rock cycle (materials)
- Identify the major geographic/geologic areas of California (surface and oceanic) and describe how they were formed (land forms)
- Create a video, book, or hypermedia presentation which illustrates the erosional processes affecting the formation of the Grand Canyon, the Mississippi or Sacramento River deltas
- Construct a geological timeline illustrating major events in earth's history (change over time)
- Plot and map the location of volcanic and tectonic activity over the past 100 years (tectonics); include mountains of California

Samples of specific activities or tasks that give students the opportunity to demonstrate that they can meet the standard:

Students will use maps showing volcanic and tectonic activity in the Pacific area to predict the location of the next island in the Hawaiian Island chain.

EARTH SCIENCE

Big Idea: Astronomy

The universe, which is evolving, contains many objects including planets, stars, moons. The laws of science apply throughout the universe.

STANDARD 19:

Student describes the bodies in the solar system and demonstrates an understanding that it is bound together by gravitation, the force of attraction that every body in the universe exerts on every other body.

Examples of the types of work students should be able to do to meet the standard:

- Construct models to explain occurrences of lunar and solar eclipses (cycles/patterns)

- Describe the effect of motion and gravitation on objects within the solar system by using models, graphs, and photographic images (e.g., tides, seasons, day and night, eclipses, phases of the moon, asteroids, comets and meteorites) (motion)
- Construct scale models of the solar system to describe the relative sizes of planets and their distances from the sun (scale and structure)
- Design a questionnaire about astronomical tools and ask an astronomical expert to answer the questions (use mail, e-mail, or visit the classroom) (tools and measurement)
- Design and build a small planetarium for the bedroom, schoolroom, or other location (systems)

Samples of specific activities or tasks that give students the opportunity to demonstrate that they can meet the standard:

Students will design an unmanned probe for exploring the surface of a nearby planet. Students will include in their design a list of important scientific tools needed to collect data. They will also include factors they will have to consider when the probe travels beyond the earth and lands on the target planet. Students will then compare their design with the design of actual unmanned space probes (e.g., Magellan, Viking, Mariner, Galileo, etc.)

EARTH SCIENCE

Big Idea: Resources

The earth has limited resources that are unevenly distributed on the earth's crust.

STANDARD 20:

Student demonstrates an understanding that humans are responsible for making informed decisions about their use of the earth's resources.

Examples of the types of work students should be able to do to meet the standard:

- Identify different types of waste present in the community and describe ways in which the community disposes of that waste (e.g., water, sewage, trash, toxic materials) (human needs)
- Calculate energy and resource costs for operating the school (resources)
- Compare the sources of the different foods in a lunch menu and design a lunch menu from items produced within a specified radius (uneven distribution)
- Compare the quality of a variety of local water sources (pH, salinity, hardness temperature, turgidity, etc.) by performing simple chemical tests (biophysical principles)
- Apply understanding of informed decision-making to a local problem and design a plan to address the issue (e.g., reduce energy and resource consumption in the school, waste disposal at the school, etc.) (informed decision-making)

Samples of specific activities or tasks that give students the opportunity to demonstrate that they can meet the standard:

Students will apply their understanding of informed decision-making by participating in a simulated land-use problem that requires them to conduct chemical analysis and draw conclusions from collected data.

For example, a decision needs to be made about whether a housing project should be built on a landfill area. Students must conduct a chemical analysis of soil at various depths throughout the site. Measurements need to be taken on temperature, pH, and salinity. Chemical tests on soil and water need to be conducted to assess contamination by toxic materials. All results need to be compared to values established by the EPA.

EARTH SCIENCE

Big Idea: Meteorology

Energy from the sun, interacting with the ocean, atmosphere, and land masses, produces climate and weather.

STANDARD 21:

Student demonstrates an understanding that solar energy is unevenly received on earth. Student explains how ocean and air currents are influenced by differential heating and how they affect global weather patterns and climate.

Examples of the types of work students should be able to do to meet the standard:

- Use a sequence of localized maps to identify patterns of weather and compare them to maps from different geographic areas to explain climatic variation (weather changes in patterns)
- Explain extreme weather phenomena—such as hurricanes, tornadoes, blizzards, and torrential rains—and describe their effects on human activity (impact on human activity)
- Collect data using the tools of meteorology to predict weather over a twenty-four hour period, and compare to the local weather forecasts (tools and tech)
- Build a model of a cloud in a jar and relate it to the water cycle (watercycle and energy)
- Explain conduction, convection, and radiation as they relate to the uneven heating of the earth and currents in the air and oceans. Design a model to show or explain the effect of the earth's tilt on seasons (energy transfer)

Samples of specific activities or tasks that give students the opportunity to demonstrate that they can meet the standard:

Students will use various weather instruments, including a thermometer, barometer, rain gauge, psychrometer, wind vane, anemometer, and altimeter. Students will collect data throughout the seasons using these instruments. They will plot the movement of weather fronts and predict the weather based upon their readings and observations.

EARTH SCIENCE

Big Idea: Oceanography

Oceans play a central role in the global ecosystem and in the formation, evolution, and continued support of life on earth.

STANDARD 22:

Student demonstrates an understanding that water from the ocean cycles in and out of the atmosphere, playing an important role in determining weather and climatic patterns. Student describes how movements within the ocean affect the global ecosystem.

Examples of the types of work students should be able to do to meet the standard:

- Relate ways in which weather patterns along the coast affect weather patterns at the school site and explain their impact on human activities (e.g., transportation, agriculture, leisure activities) (impact)

- Observe and describe ocean movements caused by wind (e.g., relate to actions in a wave tank)—observe and describe ocean movements caused by differences in heat and density (e.g., convection cells in an aquarium) (properties)
- Explain a variety of climatic change over time (droughts, ice ages, etc.) by using maps and other reference materials (change)
- Relate ways in which ocean dynamics influence coastal areas and climate (e.g., use maps, weather satellite images, audio-visual materials and periodicals to explain and track hurricane patterns over time) (interaction with land and air)
- Compare changing tides to the phases of the moon and relate to the life cycles of specified animals (e.g., grunion or sea turtles) (integration)

Samples of specific activities or tasks that give students the opportunity to demonstrate that they can meet the standard:

Students will investigate relationships between weather patterns in the United States and the location of vegetative zones. They will compare a variety of maps (temperature, precipitation, vegetation, etc.) to explain the relationships between weather, climate, and plant life.

INTEGRATED SCIENCE

Big Idea: Energy

The universe is affected by various forms of energy flowing throughout all systems. Living and nonliving systems change as a result of energy transformations.

STANDARD 23:

Student demonstrates an understanding that concentrations of powerful forms of energy can create catastrophic events.

Examples of the types of work students should be able to do to meet the standard:

- Construct map models that illustrate the gradual movement of plates carrying the continent—show the corresponding changes in flora and fauna
- Construct a paper model (U.S. Geological Survey) of a volcano and report on the energy required to produce the forces involved
- Research and record global weather conditions before and after major earthquakes and volcanic eruptions
- Research and record seismic activity before and after major earthquakes and volcanic eruptions
- Compare the flow of energy during earthquakes through various strata and types of buildings using a shake table

Sample of specific activities or tasks that give students the opportunity to demonstrate that they can meet the standard:

Students will design and present an earthquake survival plan for their family, home, and/or school. They will develop an earthquake survival kit, including procedures that their family can use.

SCIENCE TOOLS

STANDARD 24:

Students use tools to do work more easily, compare things to standard measure, and enhance the senses.

Examples of the types of work students should be able to do to meet the standard:

- Examine, measure, and identify microorganisms using a microscope
- Use computer database to store and display data
- Use a computer to create graphs and other data array
- Use simple machines to maximize work capacity
- Use the Internet to share and compare data
- Use analog and digital tools to make direct measurements
- Inspect, assemble, and reassemble simple mechanical devices and be able to describe the function of the various parts and describe how the parts affect the system as a whole
- Determine which unit of measurement best expresses the data collected—convert step-by-step to smaller or to larger units, i.e., liters per minute to milliliters per second
- Use and explain uses of science tools, including appropriate glassware, optical lenses, prisms, spectrometers, vacuum pump, hot plates, pulleys

INVESTIGATIONS

STANDARD 25:

Students investigate problems, sometimes over extended periods, and make choices about experimental design, and may include ideas, concepts, and processes using controlled experiments, previous research data, field studies, and conclusions.

Examples of the types of work students should be able to do to meet the standard:

- Collect relevant evidence, use logical reasoning, and apply imagination and intuition in devising hypotheses and explanations of natural phenomena realizing there is no fixed set of steps that all scientists follow
- Design and conduct a controlled experiment to note the effect of changing one variable
- Demonstrate use of safe and ethical investigative techniques
- Formulate questions that can be studied using the available resources
- Record data in appropriate tables and graphs
- Demonstrate application of research from life experiences, previous education, library research, and interview to an active investigation
- Frame questions so that causes and effects can be distinguished; identify variables that influence a situation that can be controlled
- Use science concepts to explain a variety of observations and phenomena
- Identify problems, propose and implement solutions, and evaluate products or designs

COMMUNICATIONS

STANDARD 26:

Students use a number of ways to communicate clearly about the natural world.

Examples of the types of work students should be able to do to meet the standard:

- Represent data and results in multiple ways; for example, with numbers, statistics; drawings, diagrams, pictures; sentences; charts and tables; models
- Argue from evidence, including one's own data and the data of others
- Critique published materials
- Explain a scientific concept or procedure to other students
- Communicate in a form suited to purpose and audience; respond to critical comments with data
- Write the steps taken to solve a problem, including any intuition and research resources used to build knowledge
- Use mathematical equations to communicate the relationships between two variables
- Use graphs to show a variety of possible relationships between two variables

IMPACT OF TECHNOLOGY

STANDARD 27:

Students identify which solutions created by scientific endeavor are most useful in light of their cost-benefit ratio, i.e., pollution, risks, practicality.

Examples of the types of work students should be able to do to meet the standard:

- Invent a solution to a common problem of society, then research the cost and practicality of proposed solution
- Research the many aspects of a current public concern which is affecting your community; analyze and record the pros and cons on each side of the debate
- Develop a solution to a design problem, consider how others have solved a design problem, and anticipate the effects of these problems
- Develop a list of current community problems and differentiate between those caused by technology and those helped by technology

DESIGNED WORLD

STANDARD 28:

Students use the resources of their environment to solve problems as people have throughout history through systematic and serendipitous problem solving and collaboration among disciplines.

Examples of the types of work students should be able to do to meet the standard:

- Use materials in different ways; identify the various ways materials have been used to solve problems in engineering, health, and agriculture
- Design a system to meet a criterion such as a strong bridge, egg drop, architectural model, model rockets, mouse trap cars
- Work in a collaborative group to solve a problem and record proposed solutions

SCIENCE STANDARDS

GRADES 9–12

THE PREPARED MIND

STANDARD 1:

Students exhibit curiosity, open-mindedness, and the ability to think critically in daily life.

Examples of the types of work students should be able to do to meet the standard:

- Insist that the critical assumptions behind any line of reasoning be made explicit so that the validity of the position being taken—whether one's own or that of others—can be judged
- Trace the source and explain the origins of any discrepancy between expected and actual outcomes
- Study, test, and modify ideas through a process of replacing old ideas with new ones which fit a wider range of observations—design controlled testing
- Develop alternative explanations of data, countering claims of a single correct solution
- Observe and utilize patterns and relationships to explain phenomena in the world
- Identify and distinguish among hearsay, opinion, fact, author prejudice, data, hype, myth, and invalid claims

PHYSICAL SCIENCE

Big Idea: Properties of Matter

There is a wide variety of matter. The properties of matter give rise to the great variety. Properties can be observed, described, and measured.

STANDARD 2:

Students show understanding that matter is composed of atoms and molecules with their own unique properties.

Examples of the types of work students should be able to do to meet the standard:

- Classify various unknowns as to whether they are mixtures or compounds, using physical separation
- Categorize the possible elements presented in an unknown substance after separation, using common chemical and physical tests
- Determine the characteristics of substances in various mixtures by separating them into purer substances by a variety of processes, such as chromatography, distillation, and crystallization
- Relate the properties of common materials such as food, rocks, metals, plastics, water, and air for their known molecular and elemental composition

Samples of specific activities or tasks that give students the opportunity to demonstrate that they can meet the standard:

Students will carry out a chemical reaction and characterize the properties of the reactant's end products. Students will propose an explanation based on the molecular, elemental properties and structure of the reactants. For example, densities vary because of the arrangement of the molecules of a substance.

PHYSICAL SCIENCE

Big Idea: Energy Transformations

Energy is transferred to and from systems of matter as they interact**,** but if all **i**nteractions are taken into account, any energy lost by one system is gained by some other system(s).

STANDARD 3:

Students show their understanding that energy cannot be created or destroyed, but only changed from one form into another. Whenever the amount of energy in one place or form diminishes, the amount in other places or forms increases by the same amount.

Examples of the types of work students should be able to do to meet the standard:

- Trace energy transfers from the radiant energy of the sun through the metabolism of corn flakes in the digestive tract
- Trace gasoline (chemical energy) in an automobile into various energy sources used in the automobile (electrical, mechanical, light, sound, heat)
- Given a variety of potential energy sources, write how the energy is released and what energies are end products (fire wood, gun powder, water behind a dam, a wax candle); given a variety of energy forms, describe how energy is moved from one source to another
- Design and build a solar-powered machine that does work
- Compare and contrast several energy sources that move in waves and describe how the energy is generated, moves, and ends as heat

Samples of specific activities or tasks that give students the opportunity to demonstrate that they can meet the standard:

Students will build a calorimeter and measure the caloric value of various nuts. They will calculate the calories per gram for their samples. Average values will be determined by using all the student's work. Caloric value will be compared to standard calorie value charts.

PHYSICAL SCIENCE

Big Idea: Light

Light has sources and properties that can be measured such as color (frequency) and intensity. Light and matter interact at the atomic level. Visible light is one form of energy on the electromagnetic spectrum.

STANDARD 4:

Students demonstrate that light has various properties, wave length, frequency, speed, and has both wave and particle characteristics–but is neither a wave nor a particle.

Examples of the types of work students should be able to do to meet the standard:

- Observe spectrographs of flame-tested samples to determine the elements
- Compare and contrast the different refractive properties of prisms using single and multiple light sources
- Compare single slit, double slit, and diffraction grating to demonstrate the wave nature of light
- Observe the colored spectrum produced when white light is passed through a prism and compare the differences in wavelengths of the various colors
- Construct a communication device using laser light
- Build a solar-powered device that has a practical application

Samples of specific activities or tasks that give students the opportunity to demonstrate that they can meet the standard:

Students design an experiment to compare and contrast the effects of varying amounts of ultraviolet light on plant growth. Findings may be presented to classmates by using graphs or other visual aids.

Students design an experiment to show that light cannot be fully explained by the wave theory or particle theory.

PHYSICAL SCIENCE

Big Idea: Magnetism and Electricity

Magnetism and electricity are related. Both are forces that have many uses in our everyday lives.

STANDARD 5:

Students demonstrate their understanding that each element is composed of elementary particles, including an equal number of electrons and protons that carry negative and positive charges respectively. The movement of charged particles produces magnetic fields.

Examples of the types of work students should be able to do to meet the standard:

- Infer the movement of electrons in a simple electrochemical cell
- Experiment with various types of metal to determine their relative electrical resistance
- Compare the scientific contributions of Edison, Tesla, Steinmetz, Watt and Ampere to our current knowledge of electricity and magnetism
- Analyze the magnetic properties of rock strata to explain how the earth's magnetic field has migrated over time

Samples of specific activities or tasks that give students the opportunity to demonstrate that they can meet the standard:

Students will build a simple electroscope, explain how the electrons are flowing in the system, develop a method for relative measurement of charge and voltage and compare voltage produced by between two metals connected chemically by an electrolyte solution (note: two nails made of different metals stuck in an orange or potato creates a voltage difference).

PHYSICAL SCIENCE

Big Idea: Changes in Matter

The properties of matter and their physical or chemical changes are affected by the conditions under which they occur, such as the amount of heat and pressure.

STANDARD 6:

Students show their understanding that chemical changes are affected by the concentration of the reactants, their temperature, and/or pressure.

Examples of the types of work students should be able to do to meet the standard:

- Compare the rate of reaction when the concentration of one reactant is increased or decreased; e.g., increasing the amount of a reactant in a baking soda-vinegar mixture
- Compare the rate of reaction when a solution of iodine, starch, and water is heated to various temperatures
- Contrast the difference between heat and temperature

- Explain, using the particulate model for matter (i.e., substances are made of particles), how concentration, temperature, surface area, and pressure are important factors in determining reaction rates
- Compare the efficiency between a supercharged and a regular automobile engine
- Investigate the role that temperature, pressure, and the concentration of particles have on urban smog formation

Samples of specific activities or tasks that give students the opportunity to demonstrate that they can meet the standard:

Students will design an experiment to determine the effects of concentration, temperature, and pressure on a chemical reaction. They will select the appropriate reagents, establish the experimental conditions, collect data, and report their results.

PHYSICAL SCIENCE

Big Idea: Structure of Matter

All matter is composed of the same fundamental building blocks.

STANDARD 7:

Atoms are composed of electrons, protons, and neutrons and may exist as ions or isotopes.

Examples of the types of work students should be able to do to meet the standard:

- Classify a group of elements according to their physical and chemical properties
- Compare the atomic structures of various elements by building simple models and locate these elements on the Periodic Table
- Compare chemical reactions involving ionic and covalent bonded molecules
- Apply the concept of ionic or covalent bonding to explain how simple molecules, such as water or carbon dioxide, are formed, using simple models
- Apply chemical knowledge to anticipate the amount of a known concentration of acid needed to neutralize a known amount of base

Samples of specific activities or tasks that give students the opportunity to demonstrate that they can meet the standard:

Students will compare and contrast the chemical properties of various families of elements on the Periodic Table, including the role that electrons and proton number plays in their placement. Students will perform simple qualitative-analysis tests on given unknown samples.

PHYSICAL SCIENCE

Big Idea: Mechanics

Unbalanced forces cause changes in motion.

STANDARD 8:

Students demonstrate their understanding that the change in motion of an object is proportional to the force applied and inversely proportional to its mass. Whenever one object exerts a force on another, an equal amount of force is exerted back on it.

Examples of the types of work students should be able to do to meet the standard:

- Compare the change in motion and direction of frictionless air pucks as different forces and masses are used
- Observe the movement of a balloon attached to a string guideline when air is released from the balloon, then diagram the forces acting on the balloon
- Observe forces when using air pucks at various angles and velocities, predict collision results, and report observations to the class
- Observe the forces on three spring scales when known forces are applied at various angles
- Measure auto skid marks to determine stopping distances of various vehicles, and use CHP charts to convert the measurements to rate (MPH)

Samples of specific activities or tasks that give students the opportunity to demonstrate that they can meet the standard:

Students will explain how an understanding of acceleration and velocity can make you a better driver. They will demonstrate how a car behaves when it slows down or speeds up around a curve.

PHYSICAL SCIENCE

Big Idea: Energy and Work

Energy can produce work.

STANDARD 9:

Students show their understanding that the more energy-efficient a system, the greater the amount of work that can be produced for each unit of energy.

Examples of the types of work students should be able to do to meet the standard:

- Compare the aerodynamics of the body shapes of two model cars and their effects on fuel efficiency
- Compare the amount of energy required to lift an object a certain height, using a single, double, and a triple pulley system
- Interview a parent or garage mechanic to get ideas on how automobiles have improved in efficiency during their lifetime and report the ideas of several people to the class
- Relate the amount of energy required to complete a task when two different machines are used; e.g., moving a heavy object from one location to another
- Compare various appliances, such as refrigerators, in terms of their energy efficiency; investigate how energy-efficient data on labels is determined for these appliances
- Apply the knowledge gained from a discussion of home energy use (e.g., utility guest speaker) by monitoring the amount of energy used at home during the various seasons

Samples of specific activities or tasks that give students the opportunity to demonstrate that they can meet the standard:

Students will design and build a model car that can only use one joule of energy to run for distance in a class competition.

PHYSICAL SCIENCE

Big Idea: Sound

Sound is produced by the vibration of matter.

STANDARD 10:

Students show their understanding that the lengths of sound waves can vary and are affected by matter. Waves are a common phenomenon exhibited by a variety of energy forces.

Examples of the types of work students should be able to do to meet the standard:

- Observe two different sound sources transmitting waves that are superimposed upon each other that reinforce or cancel each other
- Compare and contrast how various surfaces reflect or absorb sound waves, compared to the behavior of light
- Compare and contrast the differences between transverse and longitudinal waves, categorizing which one appropriately explains how sound travels under certain conditions
- Compare and contrast the differences between wave amplitude and frequency in different situations; e.g., sound produced in a stereo system
- Produce a variety of waves in wave tanks, using single and multiple sources, multiple frequencies, and a variety of barriers, to compare and contrast the relationships among these variables

Samples of specific activities or tasks that give students the opportunity to demonstrate that they can meet the standard:

Students design a model stereo sound system that efficiently produces a clear sound in a home. They need to consider the absorption and reflection properties of the home and the sound features of the stereo system.

LIFE SCIENCE

Big Idea: Cell

Cells are the basic functional unit of all living things.

STANDARD 11:

Students demonstrate an understanding that cells contain organelles that carry out life processes through a multitude of chemical reactions.

Examples of the types of work students should be able to do to meet the standard:

- Compare the functions of organelles to the processes necessary to run a school
- Use chicken eggs to demonstrate the process of osmosis and diffusion (decalcify the shells using vinegar, and test in various solutions with varying salt concentrations)
- Perform a chromatography experiment to separate plant pigment and relate them to their function
- Perform an experiment that exemplifies the relationship between photosynthesis and respiration (elodea/snail experiment)
- Build a model of DNA and use it to explain replication

Samples of specific activities or tasks that give students the opportunity to demonstrate that they can meet the standard:

Students will perform a set of experiments (e.g., liver or potato and hydrogen peroxide; crackers and saliva) to demonstrate the regulatory nature of enzymes. Students will explain and relate these experiments to the enzyme's homeostatic function.

LIFE SCIENCE

Big Idea: Structure/Function

Living things demonstrate a structure/function relationship enabling them to survive in their environment.

STANDARD 12:

Students demonstrate an understanding that in different groups of living things analogous structures carry out similar functions.

Examples of the types of work students should be able to do to meet the standard:

- Research and compare the process of respiration in an egg, tadpole, and adult frog
- Construct paper models of systems of two different fish (cartilaginous and boney); compare the similarities and differences of structures, locations and functions
- Design a future human, showing adaptations to enable it to survive a world with no ozone protective layer
- Dissect a flower's reproductive system; observe an amoeba through a microscope; and review pictures of vertebrate reproductive systems; compare the reproductive process in these three types of living things
- Research a parasitic worm that has had a major impact on human health; determine its life cycle and digestive system; compare this parasite's life cycle and digestive system to that of a free living worm

Samples of specific activities or tasks that give students the opportunity to demonstrate that they can meet the standard:

Students will observe food intake and digestion in a single-celled organism, an invertebrate and a vertebrate. Students will generate a multimedia report to explain similarities and differences.

LIFE SCIENCE

Big Idea: Diversity

Living things are diverse.

STANDARD 13:

Students demonstrate an understanding that the variation among living things within a species increases the likelihood that some members of the species will survive under changing conditions and that a great diversity of species increases the chance that some living things will survive under large changes in the environment.

Examples of the types of work students should be able to do to meet the standard:

- Infer how selective breeding and crop monoculture have both good and bad results
- Compare the DNA base sequences of various animals and describe their relationships to one another based on this comparison
- Use the results of the peppered moth study in England to explain the value of variation within a species
- Conduct a debate to address the validity of molecular evidence for variety using the DNA/fingerprinting controversy
- Relate the effects of an ice age to survival and extinction of a variety of species

Samples of specific activities or tasks that give students the opportunity to demonstrate that they can meet the standard:

Students will research the impact of humans on the diversity and survivability of their local plant and animal species. They will report their findings and predictions for the species survivability and diversity in the future.

LIFE SCIENCE

Big Idea: Heredity

Genetic characteristics are passed from one generation to another with modification.

STANDARD 14:

Students demonstrate an understanding that DNA or RNA is the genetic material of all living things and that changes in this material result in variation which may confer an advantage or disadvantage to the organism depending on the environment in which it lives.

Examples of the types of work students should be able to do to meet the standard:

- Give an example of how DNA can be altered naturally or by direct human intervention and explain the consequences
- Explain DNA testing and support a position on including it as evidence in a criminal trial
- Compare and contrast through illustrations, the stages of mitosis and meiosis; discuss the consequences of a world without meiosis; discuss how the process of meiosis leads to variation in offspring
- Explain the genetic basis of several diseases such as sickle cell anemia, Tay Sachs, Huntington's Chorea, and discuss the implications to the human gene pool
- Invent a mutation that would have allowed the dinosaurs to survive and describe how this mutation would have enabled survival; predict the frequency of this mutation in the dinosaur gene pool after 65 million years (in the present day)

Samples of specific activities or tasks that give students the opportunity to demonstrate that they can meet the standard:

Students will use models to show the roles of DNA in the transmission of genetic code from generation to generation.

LIFE SCIENCE

Big Idea: Interdependence

All living things are interdependent with their physical environment and with other living things.

STANDARD 15:

Students demonstrate an understanding that ecosystems tend toward stability but fluctuate cyclically around a state of equilibrium.

Samples of specific activities or tasks that give students the opportunity to demonstrate that they can meet the standard:

- Research a local riparian habitat, noting ecological roles of species and basic physical characteristics; evaluate the impact of changes on this habitat
- Conduct an experiment on varying physical factors (e.g., gas level, light, temperature) that affect the rate of photosynthesis of an aquarium plant
- Conduct an investigation of the effects of acid rain
- Discuss both the positive and the negative effects of human intervention on an ecosystem
- Research the effects of managed burn versus nonintervention in forest management; write a letter to a state or national park ranger stating recommendations, specifically noting the effects of different types of fires on the carbon and nitrogen cycles

Examples of the types of work students should be able to do to meet the standard:

Research a cyclical event (e.g., red tide, plague, locust, draught, fire). Describe its immediate and long-term effects on the environment.

LIFE SCIENCE

Big Idea: Evolution

Living things evolve through time.

STANDARD 16:

Students demonstrate an understanding that natural selection provides the mechanism for most evolutionary change and that shared-derived characteristics are found in the anatomy, behavior, fossil record, and biochemistry of living things.

Samples of specific activities or tasks that give students the opportunity to demonstrate that they can meet the standard:

- Relate the possible scientific reasons for the extinction of dinosaurs
- Utilize genetics to explain how a population that once had characteristic Z changed over many generations to have characteristic W instead of Z
- In the last few years, a new generation of resistant germs (“super bugs”) appears to have emerged–explain how this could have occurred
- Use a cladogram of a group of organisms to infer and describe patterns in the evolution of their adaptations, their ecologies, and their distributions
- Write a “report of information” expository essay using various types of evidence to show the evolutionary relationship between two groups of animals

Examples of the types of work students should be able to do to meet the standard:

Pick an extinct organism and a modern-day organism of a particular phylum. Describe the characteristics which increase its ability to survive. Demonstrate how each organism was adapted to its particular environment. If you could change one characteristic in order to improve the organism's ability to survive, what would it be? Justify your decision.

LIFE SCIENCE

Big Idea: Energy Flow

Living things are tied to one another and to their physical environment by the transfer and transformation of matter and energy.

STANDARD 17:

Students explain how energy and matter are transferred among organisms within ecosystems. Students demonstrate an understanding that matter is constantly cycled within ecosystems and that some energy is lost to the ecosystem and must be constantly renewed.

Samples of specific activities or tasks that give students the opportunity to demonstrate that they can meet the standard:

- Weigh and measure the volume of the materials before and after a biochemical reaction and determine the relationship between their masses; explain in terms of conservation of matter
- Perform a reaction that produces heat and record the changes in temperature; explain in terms of energy released during a chemical reaction
- Conduct an experiment on transpiration/temperature changes on a plant in a closed environment and record the results
- Experiment with a snail, plant, soil, etc. in a miniterrarium with a light source to investigate the energy flow in this ecosystem and record the results
- Design a multimedia "book" by middle school students that clearly explains the interrelationship of matter and energy in an ecosystem; change the temperature or light to test reactions

Examples of the types of work students should be able to do to meet the standard:

Students will obtain data and information on the Biosphere Project. They will relate to their own community the design features and the limiting factors of the project to sustain life.

EARTH SCIENCE

Big Idea: Geology

Geological processes explain the evolution of the earth.

STANDARD 18:

Student explains how plate tectonics causes surfaces of the continents and the bottoms of the oceans to change over time. Student demonstrates an understanding that tectonics has had tremendous effects on the evolution of life on earth, the geographical distribution of plants and animals, and changes in climate. Student describes how fossil deposits and rock formations help date when changes have occurred on earth.

Examples of the types of work students should be able to do to meet the standard:

- Observe rocks and identify their properties, relating the rocks to geological processes (e.g., lava to volcanic activity, limestone to shallow seas, granite to deep cooling of magma, etc.) (materials)
- Explain how earthquakes occur along the boundaries between colliding plates and how molten rock is released by volcanoes helping to build mountains (land forms)
- Explain how the formation, weathering, sedimentation, and reformation of rocks constitutes a continuing rock cycle which changes the surface of the earth (weathering)
- Develop a model that illustrates the age of the earth as indicated by the fossil record (change over time)
- Explain plate tectonics, relating earthquake activity, volcanoes, seafloor spreading, orientation of magnetic materials in rock, and climatic change (tectonics)

Samples of specific activities or tasks that give students the opportunity to demonstrate that they can meet the standard:

Students will construct a dig box to represent a period in geologic time. The students will apply their understanding by including examples of tectonic activity, weathering or sedimentation deposition, and fossil evidence showing climatic changes. Students will exchange boxes and reconstruct the geologic story told by that box.

EARTH SCIENCE

Big Idea: Astronomy

The universe, which is evolving, contains many objects including planets, stars, moons. The laws of science apply throughout the universe.

STANDARD 19:

Student demonstrates an understanding that the universe and planetary systems have evolved for billions of years and will continue to evolve. Student explains how scientific evidence suggests the universe is over ten billion years old.

Examples of the types of work students should be able to do to meet the standard:

- Describe the development of a star (explain how stars are born, change, develop, and die (cycles/patterns)
- Explain how the laws of gravitation account for a variety of universal phenomena (e.g., planetary orbits, galactic rotation, etc.) (motion)
- Explain how information from light received from a star allows inferences about size, age, composition, mass, and temperature (scale and structure)
- Use astronomical units to calculate the length of time it takes for light to travel between objects in the solar system and Milky Way and describe stellar distances (tools and measurement)
- Use binoculars, telescopes, or satellite maps to observe nearby galaxies and compare to photographs in order to describe similarities to and differences from the Milky Way (systems)

Samples of specific activities or tasks that give students the opportunity to demonstrate that they can meet the standard:

Students will design a test, or series of tests, to determine the age of materials discovered on the surface of the moon, Mars, and earth (What will students need to know in order to collect and analyze the

data?). They will compare the tests they designed with tests and data collected by NASA. They will apply their understanding of these concepts to explain the age of the solar system.

EARTH SCIENCE

Big Idea: Resources

The earth has limited resources that are unevenly distributed on the earth's crust.

STANDARD 20:

Students demonstrates an understanding that making informed decisions about use of the earth's resources includes consideration of several factors, including conservation of nonrenewable resources, energy conservation, the importance of earth features when making land-use decisions, and the reclamation of some resources (e.g., ground water, mining sites)

Examples of the types of work students should be able to do to meet the standard:

- Present an analysis of the advisability of using various renewable and nonrenewable resources (human needs)
- Compare the advantages and disadvantages in the use of different types of fuel sources for different parts of the country (resources)
- Present an analysis of issues related to the use of resources on a newly discovered planet (uneven distribution)
- Collect data from a number of sources, including telecommunication sources, and quantify occurrences of toxic phenomena (acid rain, smog, toxic waste spills, etc.) (biophysical principles)
- Identify a local problem and design a plan to address the issue (e.g., reduce energy consumption—personal and/or national—explaining trade-offs in terms of economic cost and social values) (informed decision-making)

Samples of specific activities or tasks that give students the opportunity to demonstrate that they can meet the standard:

Students will design and build a model home with the least impact upon the local environment. Their plan will take into consideration issues such as energy use, waste disposal, water consumption, and reclamation of earth resources.

EARTH SCIENCE

Big Idea: Meteorology

Energy from the sun, interacting with the ocean, atmosphere, and land masses, produces climate and weather.

STANDARD 21:

Student explains how climate and weather are involved in the transfer of energy in and out of the atmosphere. Student demonstrates an understanding that transfer of energy at the boundaries between the atmosphere, land, and oceans results in layers of different temperatures and densities in both the ocean and atmosphere.

Examples of the types of work students should be able to do to meet the standard:

- Explain how different temperatures and densities at the boundaries between atmosphere, land, and water affect global weather patterns (weather changes in patterns)
- Relate the physical basis of the earth's climate and weather to the effects on economic activities (for example, contrast primary economic activities in two differing climatic zones) (impact on human activity)
- Use satellite images to compare weather patterns over short periods of time at the boundaries between land and major bodies of water (tools and tech)
- Use the concepts of energy transformation to explain weather phenomena and elements of the water cycle such as fog, hail, sleet, ice, and thunderstorms and the like (watercycle and energy)
- Explain global winds, seasons, and climate using energy transformations and the earth's position in its orbit (energy transfer)

Samples of specific activities or tasks that give students the opportunity to demonstrate that they can meet the standard:

Students will make a plan to grow successful crops for their local microclimate. *Sunset Garden Book* is but one source of information for microclimates. Explain why the borders of the weather zones are where they are.

EARTH SCIENCE

Big Idea: Oceanography

Oceans play a central role in the global ecosystem and in the formation, evolution, and continued support of life on earth.

STANDARD 22:

Student demonstrates an understanding that the direction of ocean and atmospheric currents is caused by the rotation of the earth interacting with materials of different densities and land masses beneath and above the sea. Student describes the impact of ocean currents upon climate and life on earth and explains how, through geologic time, the oceans have changed in form, size, and composition, providing many different habitats in which life has evolved.

Examples of the types of work students should be able to do to meet the standard:

- Plot the major currents of the world on maps—explain the impact of ocean currents (such as El Niño) on commerce (impact)
- Explain different factors affecting ocean currents—design experiments to illustrate currents generated by wind and density differences (properties)
- Describe ways in which the Mid-Atlantic ridge remains an active source of seafloor extension (change)
- Describe the influence of the Coriolis effect on horizontally moving ocean currents (Gulf Stream, Humboldt Current) and the corresponding global weather patterns (interaction with land and air)
- Compare living things found at different depths to as many different oceanographic factors as possible (depth of the sea floor, geothermal energy sources, solar energy sources, pressure and temperature at different depths, chemical factors, etc.) (integration)

Samples of specific activities or tasks that give students the opportunity to demonstrate that they can meet the standard:

Students will predict the most likely location of a school of albacore tuna. Given a set of data about needs and behavioral patterns of tuna (temperature, water density, currents and the availability of food sources) students will predict where they would have the most success as commercial fishermen.

Students will design a raft trip around the world using ocean currents and seasonal changes to map the route. The design includes planning for food, shelter, and water needs.

INTEGRATED SCIENCE

Big Idea: Energy

The universe is affected by various forms of energy flowing throughout all systems. Living and nonliving systems change as a result of energy transformations.

STANDARD 23:

Student demonstrates an understanding that energy flows have an impact on life on this planet.

Examples of the types of work students should be able to do to meet the standard:

- Collect and record data from a variety of appropriate sources, such as the Internet and news media
- Analyze and explain how our position in the solar system affects the use of the energy from the sun to allow life forms to develop on this planet and not on the other planets in the solar system
- Compare and contrast which geological and meteorological features on earth affect life
- Describe the formation of features on the earth over time
- Identify and show relationships between the systems found on earth, such as oceans and weather
- Analyze an ecological phenomenon such as El Niño, and describe the impact this has on the various ecological and meteorological systems

Samples of specific activities or tasks that give students the opportunity to demonstrate that they can meet the standard:

Students will analyze the amount and chemical composition of rainfall in their community to see if acid rain is occurring. They will research the causes of some significant ecological phenomenon, such as acid rain, global warming, or rain-forest depletion, and its economic, ecological, and/or political impact.

SCIENCE TOOLS

STANDARD 24:

Students use tools to do work more easily, compare things to standard measure, and enhance the senses.

Examples of the types of work students should be able to do to meet the standard:

- Use computer, probes, and sensors to collect, analyze, and display data
- Acquire and record information from various print and electronic resources

- Convert measurement into various scale values, use ratio and percents to illustrate points, and convert data to graphic presentations
- Accurately measure and estimate the smallest quantity digit of a measuring device
- Understand and describe the limitations of technology in solving problems
- Record and store data in a variety of formats, including databases and audio and video tapes
- Troubleshoot common electrical and mechanical devices

INVESTIGATIONS

STANDARD 25:

Students investigate problems, sometimes over extended periods, make choices about experimental design, and may include ideas, concepts, and processes using controlled experiments, previous research data, field studies, and conclusions.

Examples of the types of work students should be able to do to meet the standard:

- Demonstrate use of procedures that are safe, humane, and ethical and that respect privacy and property rights
- Represent data and results in ways that others can verify, and analyze using skills expected at this grade level
- Represent data in ways that fit the context
- Formulate recommendations, decisions, and conclusions based on evidence
- Acknowledge and reference the contributions of others
- Frame questions that can be investigated by using scientific knowledge and techniques
- Demonstrate use of concepts expected of high school students to explain a variety of observations and phenomena
- Formulate and revise explanations and models based on evidence and logical argument, preserving significant information
- Identify problems; design opportunities; propose designs and choose among alternatives; and implement a solution and evaluate its consequences

COMMUNICATIONS

STANDARD 26:

Students use a number of ways to communicate clearly about the natural world.

Examples of the types of work students should be able to do to meet the standard:

- Propose, recognize, analyze, consider, and critique alternative explanations; distinguish between fact and opinion
- Represent data and results in multiple ways (numbers, statistics, graphs and formulas, drawings, diagrams, and pictures, sentences, charts, tables, and models) and use the most effective way to make the point
- Summarize varied sources of evidence (including one's own data and published reports)

- Critique published materials, including popular and academic sources
- Explain a scientific concept or procedure to other students
- Communicate in a form suited to the purpose and the audience; respond to critical comments with data and reasoning
- Explain differences among data, opinion, hearsay, writer prejudice, bias, and false claims in newspaper/magazine articles
- Work individually and in teams to collect and share information and ideas
- Demonstrate use of investigative vocabulary consistent with grade level, in expressing and writing about science experience
- Write steps taken to solve a problem including the use of print and electronic media and interview
- Communicate results appropriately to audiences
- Debate with peers based on conclusions drawn from one's own or others' research

IMPACT OF TECHNOLOGY

STANDARD 27:

Students identify which solutions created by scientific endeavor are most useful in light of their cost-benefit ratio, i.e., pollution, risks, practicality.

Examples of the types of work students should be able to do to meet the standard:

- Demonstrate rational decision-making skills applicable to major issues of personal and public concern
- Debate a public policy issue based on information gathered from interview, print and electronic media
- Develop and describe reasons for the limits of technology
- Determine benefits to and problems in various fields of technology

DESIGNED WORLD

STANDARD 28:

Students use the resources of their environment to solve problems as people have throughout history through systematic and serendipitous problem solving and collaboration among disciplines.

Examples of the types of work students should be able to do to meet the standard:

- Design a system to meet demanding criteria for efficiency, e.g., a cost-effective passive solar, inhabitable house